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DRUG PLANTS UNDER CULTIVATION

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THIS BULLETIN gives general suggestions relative to the culture, harvesting, distillation, yield, marketing, and commercial prospects for drug plants. Specific information is also given concerning the cultivation, handling, and yield of individual species and the demand and prices paid for the product.

The market demand for many cultivated plant drugs is not large enough to justify growing them except as small minor crops.

The haphazard production of crude drugs in small lots of a few pounds usually means a dissatisfied producer.

A special knowledge of trade requirements is necessary in collecting, curing, preserving, and packing drugs for market.

Most farm products find a ready local market; a special market must be sought for plant drugs.

High prices for plant drugs do not insure large profits in producing them. Not the price received, but the difference between the cost of production and the selling price is the important point.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C.

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DRUG PLANTS UNDER CULTIVATION.

W. W. STOCKBERGER, *Physiologist in Charge,
Drug, Poisonous, and Oil Plant Investigations.*

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PRODUCTION OF CRUDE DRUGS.

INTEREST in the possibility of deriving profit from the growing of drug plants is increasing yearly. The clearing of forests, the extension of the areas of land under tillage, and the activities of drug collectors threaten the extermination of a number of valuable native drug plants. Annually, large sums of money are expended for crude drugs imported from countries where they are grown under conditions of soil and climate resembling those of many localities in the United States. As a means of guaranteeing the future supply of crude drugs and of lessening the dependence on importations, attention is now being turned to the cultivation of drug plants with a view to increasing domestic production.

The problems presented by the cultivation of drug plants are not less difficult than those encountered in the production of many other crops. Drug plants are subject to the same diseases and risks as other crops and are similarly affected by variations in soil and climatic conditions. They require a considerable outlay of labor, the same as other crops, and likewise require intelligent care and handling. They are subject to the same laws of supply and demand, and, like other products, must conform to the consumer's fancy and to definite trade requirements.

A number of common medicinal plants have long been cultivated in gardens in this country, either as ornamentals or as a source of herbs used in cookery and as domestic remedies. A few of these plants, such as goldenseal, wormwood, wormseed, and peppermint, have been grown commercially for sale as crude drugs; but the acreage devoted to their production has been relatively small and for the most part restricted to certain localities. Other drug plants which occur as common weeds in many places may prove to respond

to cultivation; experiments should then be undertaken to determine whether it is profitable to grow them. In this connection it should be remembered that the soil type very often is an important limiting factor in propagating different kinds of plants. Some plants grow best in well-drained loam, some prefer a marsh, some require soils rich in lime, while others thrive only in acid soil. The soil requirements of all plants are not understood; in fact it is not improbable that better comprehension of the soil, climatic, and cultural conditions adapted to the different kinds of plants will enable the successful propagation of species now regarded as unsuited to cultivation. In undertaking the growing of medicinal plants, therefore, it is essential to know that the species selected for cultivation will do well under the conditions of soil and climate existing where the planting is to be made. When necessary, this should be determined on small experimental plats before undertaking commercial plantings.

Assuming that the soil and climate of the situation selected are suitable for the growing of drug plants, it does not necessarily follow that they can be produced at a profit. The cost of production and marketing may be greater than the amount received for the crop when it is sold. Some drug plants not well suited for cultivation on a large scale may be found profitable when grown on small areas as a side line. On the other hand, some may be produced more cheaply when cultivated on a scale large enough to warrant the use of labor-saving devices than when grown on small areas with the aid of hand labor alone. The value of land, the cost and availability of labor, and the possible returns from other crops are all factors to be considered carefully. On account of the variation in these factors according to locality, the same crop might prove to be profitable in one location and unprofitable in another. It is for these reasons that unqualified statements concerning the ease and profitableness of drug-plant growing should not be taken too seriously.

SOME DRUG PLANTS SUITABLE FOR CULTIVATION IN THE UNITED STATES.

The number of drug plants which may be grown in the United States is large, although the same plants are not equally adapted to the conditions of soil and climate prevailing in different sections. Often the most suitable plants for a particular locality can not be foretold, especially in those situations where no attempts have yet been made to grow them. In such cases it is well to select for cultivation plants which thrive elsewhere under conditions most closely resembling those of the new situation in which it is proposed to grow

them. The success with which ordinary field or garden crops can be grown will in general indicate the possible suitability of a given location for growing many medicinal plants. Since a number of native medicinal plants which in their wild state are restricted to certain localities have been successfully cultivated in situations far beyond their natural range, there are good reasons for believing that many such plants will thrive in sections where they are not now grown. However, good results can scarcely be expected unless the plants are placed under conditions similar to those in which they normally thrive.

In suitable soil and under favorable weather conditions the following drug plants have been found to thrive well under cultivation in numerous places in the Central and Eastern States and will probably be found suitable for cultivation in many other situations if the difference in climatic conditions is not too great:

Anise.	Conium.	Elecampane.	Sage.
Belladonna.	Coriander.	Fennel.	Stramonium.
Camomile.	Digitalis.	Henbane.	Tansy.
Caraway.	Dill.	Horehound.	Thyme.

Some perennials, such as belladonna and digitalis, are only partly hardy and would be subject to winterkilling in the colder sections. Such plants as aconite, arnica, lovage, poppy, seneca, valerian, and wormwood seem to thrive best in the northern half of the United States in situations where the rainfall is well distributed throughout the growing season. On the other hand, cannabis, licorice, and wormseed are better suited to the warmer climate of the southern half of the United States. Aletris, althaea, angelica, calamus, orris, pinkroot, peppermint, serpentaria, and spearmint are adapted generally for situations in which the soil is rich and moist, but lavender and larkspur are partial to well-drained sandy soil. Ginseng and goldenseal occur naturally on rich soil in the partial shade of forest trees and can be cultivated successfully only when planted in woodlands or in specially prepared soil under artificial shade (fig. 1).

GENERAL CULTURAL SUGGESTIONS.

The special details of cultivation for each of the medicinal plants mentioned are given under the discussion of the individual species. Suggestions which are of general application, however, are here brought together, in order to avoid unnecessary duplication.

Propagation.—A number of the species considered later can be grown easily from seed, but others are best propagated from cuttings or by division. Many wild medicinal plants are much more difficult to propagate from seeds than the species commonly grown in gardens.

Likewise, some of the species now grown abroad and suitable for cultivation in this country are not easily propagated and require special conditions if good results are to be realized.

Seeds of the better-known varieties of medicinal plants are regularly listed in the catalogues of numerous seed houses, and those which are less common can usually be obtained from dealers who make a specialty of one or more of these species. Plants can frequently be obtained from nurseries or from dealers in hardy ornamentals. The catalogues of a number of dealers should be consulted



FIG. 1.—Lath shed affording partial shade, especially well suited for growing woodland plants.

and the varieties for propagation carefully selected. In ordering, the medicinal variety should always be called for, since many of the related ornamental forms which are listed are of doubtful, if any, medicinal value.

Sowing the seed.—A relatively small number of medicinal plants can be satisfactorily grown from seed sown in the field. In many cases this method is quite uncertain and with some plants wholly inadvisable. In order to insure a good stand of thrifty plants it is frequently necessary to make the sowings in a greenhouse, hotbed, or coldframe and at a suitable time transplant the seedlings to the field. Much information on seed germination, hotbeds, and coldframes can be gained by consulting Farmers' Bulletins 934, 937, and 1044,

entitled, respectively, "Home Gardening in the South," "The Farm Garden in the North," and "The City Home Garden."

The preparation of the soil is of prime importance, whether the sowing of the seed is made in the open or under cover. Many seeds, especially those which are very small, do not germinate well in heavy soils or in those which are cloddy and coarse in texture. A seed bed prepared by thoroughly mixing equal parts of garden soil, leaf mold, well-rotted manure, and clean sand will be suitable for the germination of most seeds.

The depth of sowing is largely governed by the size of the seeds and the character of the soil. In general, the smaller the seed the less the depth of sowing. Seed should be covered more deeply in light sandy soil than in heavy clay soil. Fall-sown seeds also require a greater depth of covering than those sown in the spring. The exact quantity of seed which should be used for sowing a given area can not be definitely stated. The same kind of seed will be found to vary widely in its power to germinate; hence, the percentage of germination should be ascertained in advance of sowing and the quantity regulated accordingly. In general, the heavier the soil the larger the quantity of seed required. If the plants are to be thinned out or transplanted; or if they are especially subject to the attacks of insects, the free use of seed is usually advisable.

When plantings are made in open ground it is preferable to sow the seed in rows or drills, in order that cultivation of the soil may be possible. A shallow furrow may be opened with a rake or hand hoe and the seed sown by hand. The rake or hoe may then be used to cover the seed with the required depth of soil. It is much more satisfactory to use seed drills, such as are commonly used by market gardeners, than to sow by hand, since with the drill the depth of sowing is more uniform and the soil is compacted over the seeds, thus favoring good germination. The distance between the rows is determined in part by the size which the plants attain at maturity, but depends chiefly upon the method of cultivation to be used. A spacing of 9 to 16 inches between the rows will readily permit hand cultivation, but the rows should be about 3 feet apart if horse-drawn implements are employed.

Cultivation.—There are no set rules for the cultivation of medicinal plants, and the grower's experience with other plants must be relied upon as a guide in many of the details of cultivation. As a general rule, the soil should be worked with the hoe or cultivator at frequent intervals and kept free from weeds. It is a good practice to cultivate after a hard rain as soon as the ground is sufficiently dry.

¹ These publications can be obtained free of charge upon application to the Secretary of Agriculture, Washington, D. C.

During dry, hot weather loss of moisture from the soil will be diminished by frequent shallow cultivations.

HARVESTING.

Drug roots are usually harvested in the fall or at the end of the growing season of the plant, but they may also be harvested early in the spring while still dormant. Roots collected during the growing season often shrink excessively in drying and so do not form the most desirable product. On small areas either a spade or a potato fork is a suitable tool for digging most roots; but if the area is large, labor will be saved by using a plow to turn out the roots, especially with such crops as belladonna or burdock. Most roots require thorough washing, and when the quantity is large this may be easily done if the roots are placed on a frame covered with wire mesh and water is applied by means of a garden hose.

All roots must be thoroughly dried. Large or fleshy roots are usually split or sliced, spread in thin layers on clean floors, and stirred or turned frequently. Good ventilation is essential, as several weeks usually elapse before the roots are dry enough to be stored with safety. The proper point of dryness is indicated when the roots break readily on being bent. The time of drying may be reduced to a few days by the use of artificial heat. For this purpose the walls of a well-inclosed room are fitted with racks or shelves to receive the roots, or large trays with bottoms made of slats or wire screen are suspended one above the other from the ceiling. The room is heated by a stove, and the temperature maintained between 125° and 150° F. Ventilators must be provided at the top of the room to carry away the moisture which is driven off from the roots. Ordinary fruit driers have been used successfully in drying roots on a small scale, but special drying houses or kilns will be necessary for successfully handling crops grown on an acreage basis.

Leaves and herbs are usually harvested when the plants are in flower. Picking the leaves by hand in the field is a slow process, and time may be saved by cutting the entire plant and stripping the leaves after the plants have been brought in from the field. If the entire herb is wanted, it is preferable to top the plants, for if they are cut too close to the ground the herb will have to be picked over by hand and all the coarse stems removed. As a rule, leaves and herbs may be dried in the same manner as roots, but almost without exception they are dried without exposure to the sun, in order that the green color may be retained so far as possible.

Some flowers are gathered while scarcely open and others as soon after opening as possible, and in general they should be carefully dried in the shade to prevent discoloration. Hand picking is very

laborious, and mechanical devices similar to a cranberry scoop (fig. 2) or seed stripper (fig. 3) may often be used to good advantage. A homemade picker may be constructed as follows: From a stout wooden box, about 10 inches wide, 14 inches long, and 6 inches deep, remove one end and connect the opposite remaining sides at the top with a stout strip, which will serve as a handle. Drive long, slender wire nails through an inch strip of wood at quarter-inch intervals, thus forming a "comb" the teeth of which should be about 2 inches long. This comb is fastened to the bottom of the box in such a manner that the teeth will project outward through the opening left by the removed end. On swinging this device, teeth forward, through the flowers, the heads will be snapped off by the comb and will fall into the box, from which they may be emptied into suitable containers.

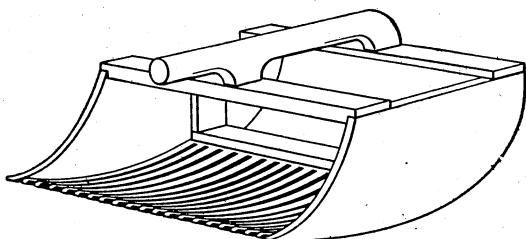


FIG. 2.—A berry scoop suitable for harvesting flower heads of large size.

Seeds are harvested as soon as most of them have ripened and before the pods or seed capsules have opened. Seedlike fruits, such as anise, coriander, fennel, and wormseed, are harvested a little before they are fully ripe, in order that they may retain a bright, fresh appearance, which adds to their market value. The machinery used for thrashing and cleaning ordinary seed crops will frequently serve a similar purpose for seeds of medicinal plants, provided the proper adjustments have been made. Most seeds must be spread out to dry and turned at intervals until thoroughly dried before they can be stored in quantity.

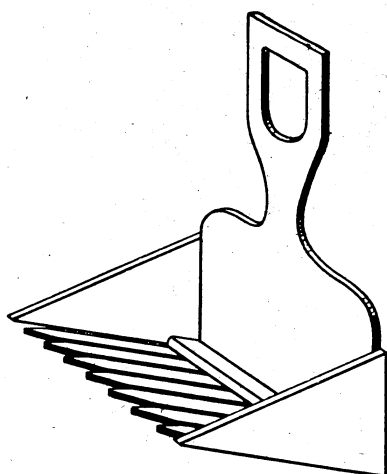


FIG. 3.—A seed stripper which may be used for gathering flower heads.

DISTILLATION.

The volatile oil obtained from many aromatic plants by steam distillation is often their most valuable product. The equipment necessary for distilling volatile oils consists essentially of a steam boiler, a retort, and a condenser. A constant supply of cold water must also be available. A common type of retort consists of a circular wooden

vat, about 6 feet in diameter and 8 to 10 feet deep (fig. 4), fitted with a removable cover, which can be made steam tight. Metal retorts made of boiler iron three-sixteenths of an inch thick and jacketed with wood to prevent the radiation of heat are also used. A pipe leads from the steam boiler to the bottom of the retort and another from the top of the retort to the condenser, one form of which consists of a coil of tin-lined or galvanized-iron pipe inclosed in a jacket through which cold water is kept flowing when the still is in operation.

When the retort is filled with aromatic plants and steam is admitted through the pipe from the boiler, the volatile oil is extracted in



FIG. 4.—A still used in the production of wormwood oil.

the form of a vapor, which is carried over with the steam to the condenser, where both are condensed to liquid form. The oil and water together flow from the condenser into the receiver, one type of which is constructed like an ordinary milk can and is fitted with a siphon leading from the bottom, through which the water is drawn off to prevent the receiver from overflowing.

Many volatile oils will float on the water and may be drawn off from the top of the receiver at will. Other oils, such as sassafras and wintergreen, are heavier than water, and should be collected in a receiver provided at the bottom with an outlet tap through which the oil may be drawn off.

The cost of setting up a still will depend upon what facilities are already at hand and upon the size and efficiency of the apparatus installed. It may easily range from a small sum to several thousand dollars.

YIELD.

The yield that can be obtained from drug plants in different localities will naturally vary according to the suitability of the situation for the plants selected for cultivation. Even in the same locality wide variations in yield will result from differences in the lay of the land and in soil, drainage, and seasonal conditions. The skill of the grower and the degree of care and attention which he bestows upon his crop are also factors affecting yield.

Many of the drug plants mentioned in this bulletin have not been grown on a scale large enough to give a very satisfactory basis for calculating yields. Acreage yields calculated from the product of small garden plats are generally untrustworthy, since in such plats the plants are usually more favorably situated with respect to soil and are given better culture than when under field conditions. Moreover, as the area increases, it becomes more difficult to maintain an approximately perfect stand and to protect the crop from the ravages of insects or other destructive agencies. The returns from small experimental areas can at most be regarded as only an indication of the yield that may be expected under favorable conditions, and the prospective grower will do well to proceed cautiously until he has determined for himself the possibilities of yield in his particular location.

MARKETING.

The commercial grower of drug plants can not give too much attention to the problem of securing a satisfactory market for his product. Growers who live near the cities in which dealers in crude drugs are located or in sections where wild medicinal plants are collected may be able to find a local market, but in many situations the local marketing of crude drugs in quantity will not be possible. In such cases the grower should send samples of his product to dealers in crude drugs or to manufacturers of pharmaceutical preparations and request them to name a price at which they would purchase his crop. The material for the samples should not be specially selected or so prepared as to represent a quality higher than that of the whole lot, since this would give the purchaser just cause for making a reduction in price on delivery or for rejecting the whole shipment. It is well to send samples to a number of dealers, since their prices will be found to vary with the stock on hand and trade prospects. Before selling, the state of the wholesale drug market should be learned. The prices to producers are, of course, always lower than the wholesale price; nevertheless, the grower who is informed in

respect to the wholesale market will be in a position to judge of the fairness of the prices offered for his crop by dealers.

Under special conditions some crude drugs can be sold at a material advance over the prevailing market price. By always supplying a well-prepared, carefully selected drug of high quality some growers have built up a trade in their particular product for which they secure extra good prices. Dealers and manufacturers also sometimes make contracts with reliable growers to take the entire crop of a particular drug, thus insuring to the grower a definite market and good prices for the product.

COMMERCIAL PROSPECTS.

At the close of the year 1919 there existed a general and widespread shortage in botanical crude drugs, and prices in consequence had reached unusually high levels. The demand in other lines for unskilled labor at high wages has attracted elsewhere many persons who were formerly engaged in the collection or production of botanic drugs in this country. It is therefore probable that prices for most crude drugs will remain at a high level until the prices of other commodities undergo a general reduction and the present supply of labor greatly increases.

Although the average value of crude drugs, expressed in terms of money, has more than doubled since 1913, it does not follow that their production offers a corresponding increase in profit to the producer. The prices of food and clothing, labor, and supplies of all kinds have for the most part more than doubled in the same time and the prospective producer of crude drugs will do well to consider carefully the comparative prices of the necessities of life which he must purchase before he engages in this enterprise. The unusually high prices now offered for many crude drugs are due to the underproduction, which has resulted largely from labor conditions and do not necessarily indicate any large increase in the demand for consumption. In view of the present disturbed economic conditions and the uncertainty as to the future course of prices, the general stimulation of drug growing in this country does not appear to be the best policy at this time.

However desirable it may be to increase the available supply of crude drugs or to diminish the amount of money now sent to foreign countries for these products, the most important consideration for the American farmer who would grow drug plants is the probable profit to be derived from such an enterprise. Many statements to the contrary notwithstanding, the commercial production of crude drugs does not normally present unusual opportunities for quick returns and large profits. Knowledge respecting the cultivation and handling of medicinal-plant crops is far less widespread than in the case of such generally distributed crops as fruits, vegetables, and

cereals, and certain individuals have taken advantage of this lack of information to lead the public to believe that extraordinary profits may be realized from growing medicinal plants, even in a situation no more promising than the average city back yard. Such persons are interested usually only in the sale of the plants and seeds for propagation or the questionable directions for their cultivation, and the extravagant claims often set forth in their alluring advertisements are not only misleading, but frequently have little basis in fact.

The market demand for any given crude drug is naturally a large factor in determining the prospects for its commercial production under cultivation. The demand for a number of drugs is quite variable or exceedingly limited, and hence insufficient to make it advisable to raise them on a large scale. In the case of other drugs, although the demand is fairly constant and steady, it could probably be fully satisfied by the product of a very few acres of good land. It is evident that the cultivation of any considerable acreage might easily result in overproduction, with a consequent decline in market price to a point where production would not be profitable.

The cultivation of drug plants, to be successful in this country, will probably require the introduction of improved methods and the extensive use of machinery to replace hand labor so far as possible. Growers of mints and numerous other plants yielding essential oils will find it desirable to equip themselves with a suitable distilling plant, although the latter can not be operated most economically when only a small quantity of material is available for distillation. The natural tendency will be to increase the acreage in the interest of more efficient operation, but here again there is danger of overproduction, and prospective growers should thoroughly acquaint themselves with market conditions before bringing very large areas under cultivation.

Very few, if any, drug plants are used in quantities sufficient to make them a promising crop for general cultivation. Many of the common ones, which can be grown and prepared for market with little difficulty, bring but a few cents a pound, and their cultivation offers little prospect of profit. A number of the high-priced drug plants must be given care for two or more years before a crop can be harvested, and, since expensive equipment is usually required for their successful culture, the production of such crops offers little encouragement to inexperienced growers who are looking for quick returns and large profits from a small investment. The production of drugs of high quality requires skilled management, experience in special methods of plant culture, acquaintance with trade requirements, and a knowledge of the influence of time of collection and manner of preparation on the constituents of the drug which determine its value. Small quantities of drugs produced without re-

gard to these conditions are apt to be poor in quality and so unattractive to dealers and manufacturers that the product will not be salable at a price sufficient to make their production profitable. In general, the conditions in this country seem far more favorable to the growing of drug plants as a special industry for well-equipped cultivators than as a side crop for general farmers or those whose chief interest lies in the production of other crops.

Although a number of plants which yield products used as crude drugs are common farm weeds, they usually occur in scattered situations and in such small quantities that their collection would scarcely prove profitable for the farmer. Even when relatively abundant it is a matter for careful consideration whether the time and labor necessary for their collection might not be otherwise employed to better advantage. Moreover, it is not always easy to distinguish medicinal plants from others of similar appearance, and collectors not infrequently find that they have spent their time in gathering plants practically worthless as crude drugs. In proportion to the labor required in their collection, relatively low prices are paid for most crude drugs obtained from wild plants, and the farmer who turns to drug collecting as a source of additional revenue will probably meet with disappointment.

THE CULTIVATION AND HANDLING OF DRUG PLANTS.

The following cultural directions and suggestions regarding the handling of a number of drug plants have been compiled in part from the records of the Office of Drug, Poisonous, and Oil Plant Investigations and include data secured by various members of the staff of that office connected with testing gardens in several widely separated localities. The probable yields per acre are in many cases estimates calculated from smaller areas, and considerable variation from the figures given must be expected in actual practice. The prices mentioned are given merely to indicate the comparative value of the products concerned and not to fix the actual price which the grower of drug plants may expect to receive. This will depend very largely upon the state of the market at the time the crop is offered for sale.

The plants mentioned in the following pages were selected for discussion because information regarding their cultivation is in constant demand. The purpose of this bulletin is not to recommend these plants for cultivation, but to give information concerning their culture which may be helpful to persons who are considering the production of drug plants on a commercial scale.¹

¹ For information in regard to weeds used in medicine not herein considered, see *Farmers' Bulletin* No. 188, which may be obtained from the Superintendent of Documents, Government Printing Office, for 5 cents.

ALETRIS.

Aletris, star-grass, or true unicorn root (*Aletris farinosa*, fig. 5) is a native perennial herb of the lily family, found occasionally on sandy soil throughout the eastern half of the United States; also frequently occurring in the pine and oak barrens of Alabama and Tennessee and elsewhere in the South. The root is used medicinally.

Aletris is a slow-growing plant which seems to thrive best on a moist and sandy soil. It may be propagated either by division of the root stocks or from seeds. The seeds mature late in the summer, and should be sown soon after ripening, in a well-prepared and protected seed bed. In the following spring the seedlings may be transplanted to their permanent situation and set about a foot apart in rows 20 inches or more apart. The soil about the plants should be stirred frequently and kept free from weeds.

The root, consisting of a short horizontal rootstock bearing numerous small rootlets, may be harvested in the fall of the second or third year. In preparing the root for market the stem and leaves are broken off and the dirt is removed by shaking (or washing, if necessary), after which it is well dried. There are no available data on the probable yield. The prewar prices paid to collectors for aletris usually ranged from 12 to 25 cents a pound. The prices in June, 1920, were about 70 cents a pound.



FIG. 5.—Aletris (*Aletris farinosa*).

ACONITE.

Aconite (*Aconitum napellus*) is a hardy perennial, introduced from Europe and sparingly grown in this country as an ornamental garden plant. Both leaves and roots are very poisonous, the latter forming the official drug. Other varieties than *Aconitum napellus* are also grown in flower gardens, and several species occur wild in the United States. Since the official species readily hybridizes with related varieties, often to the detriment of its medicinal properties, it is frequently difficult to secure seed which will come true to name.

Aconite seems to thrive best in a rather cool climate and will grow in any rich garden soil, but a well-drained gravelly loam in an elevated situation appears most suited for the cultivation of this plant. It may be grown from seed sown in the open late in the fall or early in the spring, or plants may be started in a seed bed and the seedlings later transplanted and set about a foot apart in rows 2 feet apart. The preferable method of propagation is by division of the roots after the stems have died down in the fall, since thereby hybridization may be avoided.

The plants usually flower in the second year from seed, when the roots may be harvested. It is preferable, however, to defer harvesting until the stems have died down in the fall, when all the roots should be dug, the smaller reserved for planting and the larger ones washed, sliced lengthwise, and dried. The leaves are also harvested, but are not in much demand.

Reliable data on yield are not available, although some estimates place the yield at about 450 pounds of dry root per acre. The American market is supplied with imported aconite root, for which the prewar price ranged from about 9 to 15 cents a pound. The price in June, 1920, ranged from 60 to 62 cents a pound. The quantity imported in 1919 was about 35,000 pounds. The demand for this drug is limited, and this fact, together with the probable low yield, makes its profitable cultivation in this country very doubtful.

ALTHAEA.

Althaea, or marshmallow (*Althaea officinalis*), is a perennial herb introduced from Europe which now grows wild in marshy places near the sea in Massachusetts and along tidal rivers in New York and Pennsylvania. The root forms the official drug, but the leaves and flowers also are sometimes used medicinally.

Althaea will grow well in almost any loose garden soil of moderate fertility, but tends to winterkill in situations where the ground freezes to a considerable depth. The plants may be propagated from seeds or from divisions of the old roots made early in the spring. The seed may be sown in the open in shallow drills at least 3 feet apart, and the seedlings should be thinned to stand 16 inches apart in the row. Under good conditions the plants attain a height of 3 or 4 feet; therefore, close planting does not give sufficient room for full development.

In the second year of growth the roots are harvested, washed, peeled, cut into short lengths, and thoroughly dried. Yields at the rate of 800 to 1,000 pounds of dry root per acre have been obtained. The prewar wholesale price usually ranged from 12 to 20 cents a pound. The price in June, 1920, was 25 to 27 cents a pound. The annual importation of this root averages about 30,000 pounds. In view of the amount of hand labor required in preparing the root, the relatively low price, and the rather limited demand, the cultivation of this plant for profit is not very attractive.

ANGELICA.

Angelica (*Angelica officinalis*) is a European biennial plant of the parsley family, sometimes grown in this country as a culinary herb and known commonly as garden angelica. The fresh stems and leafstalks are used as a garnish and for making a candied confection. The seeds and the oil distilled from them are employed in flavoring, and the aromatic roots are sometimes used in medicine.

Angelica thrives best in a moderately cool climate and may be grown in any good soil, although a deep, fairly rich loam which is moist but well drained will give the best results. The soil should be deeply plowed and well prepared before planting. The plant is most readily propagated from divisions of old roots, which may be set either in the fall or spring about 18 inches apart in rows. The seeds germinate very poorly if more than one year old, and it is best to sow them as soon as they are ripe in a seed bed, which should be kept moist by frequent watering if necessary. Early in the following spring the seedlings are transplanted and set about 2 feet apart each way in their permanent location. Plants may also be obtained from seeds sown in March in a spent hotbed or in a cold frame. In order to increase the root development, the plants are often transplanted a second time, at the end of the first year's growth, and set 3 or 4 feet apart. For the same reason the tops are often

cut back to prevent the formation of seed. During the growing seasons the soil should be kept mellow and free from weeds by frequent cultivation.

The roots are usually harvested in the fall of the second year, but sometimes those of the first-year plants are marketed. After being dug, the roots are washed and dried in the open air. In order to keep out insects and to preserve the aroma it is best to store the dried root in tin containers which can be tightly closed. The root of the European or garden angelica found in our drug markets is imported largely from Germany. During the past few years the wholesale price has averaged about 20 cents a pound.

The root of a native species of angelica (*Angelica atropurpurea*), commonly called American angelica, also occurs in the drug markets of this country. It is collected from wild plants, and the price to collectors in former years usually ranged from 6 to 10 cents a pound. The prices in June, 1920, were for the seed 20 cents and for the root 14 cents a pound.

ANISE.

Anise (*Pimpinella anisum*) is an annual herb of the parsley family, widely cultivated in Europe and to a limited extent in this country, chiefly in Rhode Island. Although this plant may be grown quite generally throughout the United States, it has been found difficult to bring the crop to maturity in northerly situations where the growing season is short or in the South where the climate is hot and dry. It is grown chiefly for its aromatic seeds (fruits), which are used medicinally, and also in baking and for flavoring confectionery. The oil distilled from the seeds is used medicinally in cordials and also for flavoring various beverages.

Anise thrives best in a light, moderately rich, and well-drained loam which has been carefully prepared before planting. It is grown from seeds, which are usually sown early in the spring directly in the field, since the seedlings are unfavorably affected by transplanting. The seeds, which should not be more than 2 years old, are sown thickly, about two to the inch, and covered one-half inch deep. Since the plants develop very slowly, seed should not be sown in weedy soil. When the seedlings are 2 to 3 inches high they are thinned to stand 6 inches apart in the row. The rows may be 18 inches or 3 feet apart, depending on the cultivation intended. An ounce of seed should sow a row 150 feet long, and about 5 pounds will plant an acre when the rows are 3 feet apart. The plants should receive frequent and thorough cultivation throughout the growing season.

About three months from the time of planting the plants will blossom, and a month later the seed should be matured sufficiently for harvesting. As soon as the tips of the seeds turn a grayish green color they should be harvested, for if allowed to remain exposed to the weather they quickly turn brown or blacken. The plants may be pulled by hand and stacked, tops inward, in heaps about 6 feet high, or they may be mowed and at once built up into cocks of the same height. In about four or five days the seed will have ripened, after which it should be thrashed out and thoroughly cleaned.

Yields of anise seed are quite variable, since the plant is very sensitive to unfavorable weather conditions. In a good season from 400 to 600 pounds per acre may be reasonably expected. The prewar wholesale price usually ranged from 6 to 8 cents a pound. The prices in June, 1920, ranged from 19 to 30 cents a pound. During the war the average annual importation of 500 tons was reduced to about 180 tons.

ARNICA.

Arnica (*Arnica montana*) is a herbaceous perennial plant of the aster family, native in northern and central Europe, where it thrives in the cool climate of the mountain meadows and upland moors. The flowers, leaves, and roots are employed in medicine.

Arnica requires a marshy soil, abundant rainfall, and a cool climate for its best development. It is propagated by divisions of the roots or from seeds sown either in the fall or the spring. Seed may also be sown in August in a seed bed and the plants transplanted the following spring to stand about 18 inches apart in the row. The flowers may be harvested the second year and the roots after three or four years.

Arnica is not produced commercially in the United States, and the small quantity imported annually is apparently sufficient to meet the market demands. Its cultivation presents many difficulties, and efforts to grow it in the milder portions of this country have generally proved unsuccessful.

BELLADONNA.

Belladonna, or deadly nightshade (*Atropa belladonna*), is a large, poisonous perennial which occurs wild in Europe, where it is also cultivated. Both the leaves and the roots are important crude drugs. In recent years it has been cultivated to some extent in this country, but is likely to winterkill in the colder sections.

Belladonna may be propagated in a small way from cuttings of the young shoots rooted in moist sand in the usual manner or from divisions of the fleshy rootstocks made early in the spring, but it is most readily grown from seeds which may be thinly sown in pots or well-drained boxes in a cool greenhouse in midwinter or in a sheltered place in a garden early in the spring. When the seedlings are large enough to handle they should be transplanted singly to small pots or pricked out in flats or shallow boxes of light, rich soil, placing them about 2 inches apart each way, as with tomato or other vegetable plants intended for field planting. In the spring, as soon as danger from frost is over, they should be transplanted to the field and set about 20 inches apart in rows 30 or more inches apart. Sowing seeds in the field or transplanting directly from the seed bed to the field has rarely given good results in this country. Belladonna seeds are small, and if well handled under glass or in protected seed beds 1 ounce should produce 10,000 or more plants, sufficient to set an acre.

Belladonna thrives best in deep, moist, well-drained loam containing lime, such as will under proper fertilization produce good garden vegetables. The preparation of the soil should be very thorough and consists of deep plowing, either in the fall or early spring, and repeated working with the disk or spring-tooth and smoothing harrows. Weeds should be kept under control at all times and the soil stirred with a hoe or cultivator at intervals of about 10 days, particularly after each hard rain, and shallow cultivation given in hot, dry weather to conserve the natural moisture of the soil. Good commercial fertilizers, such as are commonly used in truck gardens, are beneficial. Those containing 8 per cent of phosphoric acid, 4 per cent of nitrogen, and 4 per cent of potash are the most desirable and should be applied at the rate of about 600 pounds per acre. Stable manure at the rate of 12 to 20 tons to the acre may be used if plowed under when the ground is prepared.

Belladonna is sometimes affected by a wilt disease, which is aggravated by wet soils and fresh animal manures, and the foliage is greedily attacked by the potato beetle. Dusting with lime, soot, or road dust in the morning when the

leaves are wet with dew is occasionally effective. The destructive attacks of these pests are usually confined to the seed bed or to first-year plantings, but the insects may be controlled by the careful use of insecticides.

The leaves are picked when the plants are in full bloom. They should be carefully handled, to avoid bruising, and dried in the shade in order to retain their green color. A hundred pounds of fresh leaves yield about 18 pounds when well dried. One crop only can be collected the year of planting, but two crops are gathered in each of the next two or three years, after which it appears better to market the roots and make new plantings. While only the leaves should be collected for the best pharmaceutical trade, the young growth, including the smaller sappy twigs, has medicinal value and may be sheared from the plants and dried in the same manner as the leaves. The ease of collection and increased weight of material may render the latter method more profitable.

The roots alone are not as profitable as the leaves. The best roots are those of the second and third year's growth. They are harvested in the fall after frost, the tops being mowed and raked off and the roots turned out with a deep-running plow, or with a potato fork if the area be small. They are carefully washed and cut into about 4-inch lengths, the larger pieces being split lengthwise to aid in drying. Thorough drying either in the sun or with mild artificial heat is essential; otherwise, the roots will mold when stored.

The high prices paid for belladonna during the war greatly stimulated the cultivation of this crop, which had previously been grown with some success in California, Michigan, Indiana, Pennsylvania, New Jersey, and some other States. In 1918, 273 acres of belladonna were harvested, the total production being about 83 tons of herb (including leaves and stems), an average of 600 pounds per acre. From 136 acres 11 tons of root were harvested, an average of 164 pounds per acre. The marketing of this crop was followed by a decline in prices, the quotations in June, 1920, being 30 to 35 cents a pound for the herb and 55 cents a pound for the root.

BLUE FLAG.

Blue flag (*Iris versicolor*) is a native perennial plant of common occurrence in swamps and marshy situations throughout the eastern half of the United States. The underground stem (rhizome) and roots are the parts of the plant used medicinally.

Blue flag responds readily to cultivation when placed in a rich, moist, and rather heavy soil. It is readily propagated from divisions of old plants, which may be set 1 foot apart in rows spaced conveniently for cultivation. If the plants are set in August or September, the crop may be harvested about the last of October in the following year. The roots may be turned out with a deep-running plow, and after being thoroughly washed and the larger clusters broken up they should be thoroughly dried. Artificial drying at low heat is usually desirable.

Yields at the rate of 3 or 4 tons of dried root per acre have been obtained from small plats. The prewar price paid to collectors varied from year to year and usually ranged from 5 to 10 cents a pound. The price in June, 1920, was 35 cents a pound. This crop does not appear to be very promising, owing to the relatively small demand for the root.

BONESET.

Boneset (*Eupatorium perfoliatum*) is a hardy, rather long-lived perennial plant commonly found growing in low grounds throughout the eastern half of the United States. The dried leaves and flowering tops form the official drug.

Divisions of clumps of wild plants collected early in the fall will serve for propagation. These may be set about a foot apart in rows in well-prepared soil. During the first winter the newly set divisions should be protected with a light mulch of straw or manure. Plants may also be grown from seeds, which should be collected as soon as ripe and sown in shallow drills about 8 inches apart in a rich, moist seed bed, preferably in partial shade. When of sufficient size they may be set in the field at about the same distance as the divided clumps.

The plants are cut late in the summer when in full bloom and the leaves and flowering tops stripped from the stem by hand and carefully dried without exposure to the sun. Yields of well-cultivated boneset are quite large and 2,000 pounds or more per acre of dry herb may be obtained under favorable conditions. The prewar price for boneset rarely exceeded 2 to 3 cents a pound. The price in June, 1920, was 12 to 13 cents a pound. Since the demand is limited and the wild supply fairly available, the cultivation of boneset does not offer much prospect of profit.

BURDOCK.

Burdock (*Arctium lappa*) is a large biennial plant well known as a common and troublesome weed in the Eastern and Central States and in some western localities. The dried root from plants of the first year's growth forms the official drug, but the seeds and leaves are also used medicinally.

Burdock will grow in almost any soil, but the best root development is favored by a light well-drained soil rich in humus. The seeds germinate readily and may be sown directly in the field, either late in the fall or early in the spring. The seed may be sown in drills 18 inches or 3 feet apart, as desired, and should be sown 1 inch deep if in the fall, but less deeply if sown in the spring. When the seedlings are well up they should be thinned to stand about 6 inches apart in the row. Cultivation should continue as long as the size of the plants will permit.

The roots are harvested at the end of the first year's growth in order to secure the most acceptable drug and also to prevent the plants from bearing seed and spreading as a weed. The tops of the plants may be cut with a mower and raked off, after which the roots can usually be turned out with a deep-running plow or with a beet lifter. In a dry and very sandy soil the roots frequently extend to a depth of 2 or 3 feet, making it necessary to dig them by hand. After digging, any remaining tops are removed and the roots are washed and dried, the drying being preferably by the use of low artificial heat. The roots are usually split lengthwise into two or more pieces in order to facilitate drying, although whole roots are marketable.

Yields at the rate of 1,500 to 2,000 pounds of dry roots per acre have been obtained. The prewar prices offered by dealers ranged from 4 to 6 cents a pound. The prices for the root and seed in June, 1920, were 12 cents a pound each.

CALAMUS.

Calamus, or sweet flag (*Acorus calamus*), is a native perennial plant, occurring frequently along streams and in the edges of swamps throughout the eastern half of the United States. The dried root (rhizome or rootstock) is the part used as a drug.

Although calamus in a wild state is usually found growing in water, it may be cultivated in almost any good soil which is fairly moist. It usually does well on moderately dry upland soils which will produce fair crops of corn or potatoes. The plants are readily propagated from divisions of old roots, which should be set early in the fall 1 foot apart in rows and well covered. During

the following growing season the plants should receive frequent and thorough cultivation.

The roots are harvested in the fall and may be readily dug with a spade or turned out with a plow. The tops, together with about an inch of the rootstock, are next cut off and used to make new plantings. The roots are washed and dried artificially at a moderately low degree of heat. The marketable product consists of the thick rootstocks deprived of their small rootlets, often called "fibers." These may be removed before drying, but more easily afterwards, since when dry and brittle they break off readily with a little handling. Roots thus treated are often called "stripped" and are more aromatic than those which have been peeled.

Yields at the rate of 2,000 pounds of dry roots per acre have been obtained. The prewar price for the unpeeled root usually ranged from 3 to 5 cents a pound. The prices in June, 1920, were 10 to 12 cents a pound. The annual importation of calamus root ranges from 5 to 10 tons.

CALENDULA.

Calendula, or pot marigold (*Calendula officinalis*), is a hardy annual plant native to southern Europe, but frequently grown in flower gardens in this country. The dried flower heads are sometimes used in soups and stews, and the so-called petals (ligulate florets) are employed in medicine.

Calendula grows well on a variety of soils, but a moderately rich garden loam will give the best results. The seed may be sown in open ground early in the spring in drills 18 inches apart. As soon as the seedlings are well established they should be thinned to stand about a foot apart in the row. In the North it is desirable to sow the seed about the first of April in coldframes or spent hotbeds and transplant the young seedlings as soon as the danger of frost is past.

The plants blossom early and continue to bloom throughout the summer. The flowers are gathered at intervals of a few days and carefully dried. The petals (florets) which form the drug may be removed either before or after the flower heads are dried. The petals are removed by hand, but this process requires so much time that when the cost of the necessary labor is taken into account it is doubtful whether the price received for the drug would cover the cost of production.

The dried whole flowers produced in this country were quoted in the wholesale markets in June, 1920, at 25 cents to \$1 a pound, according to quality; the petals, at \$1.95 to \$2.10 a pound.

CAMOMILE, GERMAN.

German camomile (*Matricaria chamomilla*) is a European annual herb of the aster family, cultivated in this country in gardens, from which it has escaped in some localities. The dried flower heads are used in medicine.

This species of camomile does well on moderately heavy soil which is rich in humus and rather moist. Since the plants bloom about eight weeks after sowing the seed, a crop of camomile may be grown from seed sown either early in the spring or late in the summer, following early vegetable crops. The seed may be sown in drills and barely covered or may be broadcast, since the plants will soon occupy the ground and exclude the weeds. When the plants are in full bloom the flower heads are gathered and may be spread thinly on canvas sheets and dried in the sun. All leaves and stems should be removed, and when the flowers are thoroughly dry they should be packed for market in boxes or bales rather than in bags, since in the latter the flowers are likely to be badly broken in handling.

Returns from experimental areas indicate that a yield of about 400 pounds of dry flowers per acre may be expected under favorable conditions. Prewar wholesale prices usually ranged from about 15 to 40 cents a pound. The prices in June, 1920, were 41 to 43 cents a pound.

CAMOMILE, ROMAN.

Roman camomile (also called English camomile, *Anthemis nobilis*) is a European perennial herb of the aster family, frequently cultivated in gardens in this country and sometimes found growing wild. In America, camomile is grown chiefly as an ornamental plant, especially for use in borders, since the plants blossom from midsummer until killed by frost. The dried flower heads from cultivated plants are used in medicine.

Camomile grows well in almost any good, rather dry soil which has full exposure to the sun. The plants may be grown from seeds or propagated by dividing the roots early in the spring. The divisions of the root may be planted 9 inches apart in rows spaced according to the method of cultivation to be used. When planted on a small scale the divisions, or offsets, may be set 9 inches apart each way in carefully prepared soil. Hand weeding is necessary, but since the plants soon spread and fully shade the ground, weeds usually have small chance of becoming troublesome.

The flower heads are gathered just as they open, either by hand or by means of a flower picker, and are dried in the open in bright weather or, when necessary, on canvas trays in a heated room. Rapid drying is essential, as it is desirable to retain the white color as far as possible.

The yield is variable, but from 400 to 600 pounds of dried flowers per acre may be expected. The prices for Roman camomile quoted in the wholesale drug markets of this country prior to the war usually ranged from about 10 to 12 cents a pound. The prices in June, 1920, were 18 to 20 cents a pound. Since this crop requires much hand labor, its cultivation in this country on a commercial scale does not promise to be very profitable.

CAMPBOR.

The camphor tree (*Camphora officinalis*) is a large evergreen, native to Asia. It is hardy in situations where the winter temperature does not fall below 15° F., and for many years has been grown as an ornamental in the southern and southwestern United States. Young trees suitable for planting as ornamentals may usually be obtained from the nurseries in Florida and other parts of the South, or they can be easily grown from fresh seed.

For culture on a commercial scale the climatic requirements of camphor are practically the same as those of citrus fruits. The tree can be grown in almost any soil, but the maximum growth is secured in soils which are rich and well drained. When planted for commercial cultivation new land is preferable. The following statements are based upon actual experiments and observations on the growing and production of camphor under conditions found in Florida.

Camphor seeds ripen about the middle of October and should be planted while fresh, a better germination being obtained when the pulp is removed. The seed bed should be selected with care and the precaution taken to have one that will give sufficient moisture during the dry season and yet be well drained. For small seed beds of 2 or 3 acres or less it may be practicable to provide irrigation. Excellent stands of seedlings have been obtained on slightly rolling land which originally was covered with "blackjack" oak.

About the first of September, or somewhat earlier if conditions permit, the land should be well plowed and thoroughly worked down with a disk harrow. Just before the seeds are planted it should again be worked over and all roots of Bermuda grass or other weeds removed, since rapidly growing grasses or weeds will absorb so much moisture from the soil that the seeds can not germinate.

The seeds begin to ripen during the first part of October and are usually in a fairly well ripened stage by the last of that month. From this time until the heavy frosts they can be gathered and planted with safety. Seeds gathered after heavy frosts have been planted successfully, but it is not advisable to take the risk of too hard a freeze. In determining the time to gather seed a simple test is sufficient. Seeds that fall into the hand when the cluster is slightly twisted are ripe enough to plant.

In planting, a cotton-dropping machine, modified somewhat to meet the new requirements, may be used. The machine is set to plant the seeds 2 or 3 inches apart and cover them 1 inch deep in rows far enough apart to permit horse cultivation. The plants begin to come up in about three months, but four or five months are often required for a full stand. As soon as the plants can be distinguished in the rows cultivation is begun, which at first is done by hand with either a wheel or hand hoe. Later, as the plants attain size, a horse cultivator can be used, but a certain amount of handwork is necessary throughout the time the plants remain in the seed bed. When the plants are well started they should receive a good application of sheep or goat manure or of high-grade fertilizer.

The first season a growth of from 3 to 18 inches may be expected, the irregularity of development depending on the vitality of the seed, variation in the soil, and numerous other factors. The plants are allowed to grow in the seed bed usually for a year and are then transplanted to the field. In transplanting it is customary to separate the plants into two grades, "sturdy" and "weak" planting each grade in a field by itself. By doing this the replanting is simplified, since the sturdy stock requires but few trees for replanting and the weak stock, which will require considerable replanting, is all in one section.

Previous to transplanting, the land is well prepared by deep plowing and thorough harrowing, and rows are laid off 15 feet apart. The young trees are set in these rows 4 feet apart, either by hand or with a tree-setting machine. This machine is simply a tobacco-setting machine fitted with a trench opener set to open a furrow 8 inches deep, in which the trees are placed. The trees used for transplanting are headed back to within 1 inch of the crown, and the lower end of the taproot and all large laterals are removed. The taproot of the tree as planted is thus reduced in length to 8 or 10 inches and varies in diameter according to the vitality and previous growth of the seedling. Transplanting should be done in the winter months, when the trees are dormant.

Cultivation is begun as soon as the trees put forth shoots in the spring and continued until the rainy season of each year. After the rainy season the plants are again cultivated and all grass and weeds removed. At times cultivation is necessary during the rainy season in order to keep the trees from becoming smothered and killed by the fast-growing weeds. One-horse cultivators drawn by mules or a gang cultivator drawn by a light tractor may be used.

In three or four years, after transplanting, the trees should be from 7 to 8 feet high. They are then trimmed by means of a special machine¹ to form an

¹ A detailed description of this machine is given in U. S. Dept. of Agr. Cir. 78, entitled "A Machine for Trimming Camphor Trees." 1920.

A-shaped hedge and the trimmings distilled for the oil and camphor gum. Trimming is carried on when the trees are in the dormant stage, which is twice each year, usually November to January and May to June. The summer dormant season is somewhat irregular and governed entirely by local conditions.

The cuttings are hauled from the field to the distilling plant, and if many large branches are present they are run through a heavy ensilage cutter. For distillation they are packed in large iron retorts, to which steam is admitted at the bottom. The outlet pipe of the retort is connected with a specially constructed condensing apparatus in which the oil and camphor carried over by the steam are condensed and partly collected. Portions of oil and camphor not collected in the condenser are caught in a tub fitted with an outlet siphon which carries away the excess condensed steam but leaves the oil and camphor behind.

When removed from the condenser the product is very crude, consisting of a mixture of oil, water, and camphor. This mixture is either thrown into a centrifuge and the oil and water removed or it is placed in large cylindrical vats and the oil and water allowed to drain out. The oil is then separated from the water by means of a siphon. The camphor and oil are marketed separately.

The annual yield of cuttings has varied from 2 to 5 tons per acre, which should give approximately 40 to 100 pounds of marketable camphor. At present the planting of small areas does not seem advisable, in view of the heavy outlay required for the machinery necessary to produce camphor gum at a profit. An area of less than 500 acres would probably not warrant the installation of the machinery necessary for the commercial production of camphor, and 1,000 acres or more will doubtless give a greater net return per acre. Although the crop is a low-priced one, under favorable conditions it is estimated that a fair return per acre may be expected, but the data so far accumulated are not sufficient to warrant specific statements concerning the profitability of the industry.

Camphor oil, or the oil from which camphor has been removed, is used in Japan for illuminating purposes and as a solvent for resins in the manufacture of lacquer. It is used in Europe for its safrol content, and may probably be utilized for the same purpose in this country. There exists already in the American market a demand for the Japanese oil at prices ranging from 11 to 14 cents per pound.

Camphor imports into the United States usually exceed 3,000,000 pounds annually; hence, it does not seem probable that there is any danger of overproduction in the Southern States. However, it is possible that at times camphor may be imported at a price so low as to render production in this country financially unprofitable.

CANNABIS.

The drug cannabis or Indian hemp (*Cannabis sativa*), consists of the dried flowering tops of the female plants. It grows well over a considerable portion of the United States, but the production of the active principle of this plant is believed to be favored by a warm climate. For drug purposes, therefore, this crop appears to be adapted to the Southern rather than to the Northern States.

Cannabis is propagated from seeds, which should be planted in the spring as soon as conditions are suitable, in well-prepared sandy or clayey loam at a depth of about an inch in rows 5 or 6 feet apart. The seeds may be dropped every two or three inches in the row or planted in hills about a foot apart in the row, 6 to 10 seeds being dropped into each hill. Two or three pounds of seed per

acre should give a good stand. About half the seeds will produce male plants, which must be removed before their flowers mature; otherwise, the female plants will set seed, thereby diminishing their value as a drug. The male plants can be recognized with certainty only by the presence of stamens in their flowers.

Ordinary stable or barnyard manure plowed in deeply is better for use as a fertilizer than commercial preparations and may be safely applied at the rate of 20 tons per acre. However, good results may be obtained with commercial fertilizers, such as are used for truck crops and potatoes, when cultivated in between the rows at the rate of 500 or 600 pounds per acre.

When the female plants reach maturity, a sticky resin forms on the heavy, compact flower clusters, and harvesting may then be begun. The tops of the plants comprising the flower clusters are cut and carefully dried in the shade to preserve the green color as far as possible. Drying can best be done, especially in damp weather, by the use of artificial heat, not to exceed 140° F.

For several years cannabis of standard (U. S. P.) quality has been grown on a commercial scale in this country, chiefly in South Carolina and Virginia. After the flowering tops are harvested they are thoroughly dried under cover, then worked over by hand, and all the stems and large foliage leaves removed. This process gives a drug of high quality but greatly reduces the net or marketable yield per acre, which usually ranges from 350 to 400 pounds. Some growers do not remove the stems and leaves, thus increasing the acreage yield but reducing the market value of their product. The quality of cannabis can be determined only by special laboratory tests, which most dealers are not equipped to make; consequently, they are usually unwilling to pay growers as high prices as they would if the low-grade cannabis were kept off the market.

The market price in June, 1920, for tested (U. S. P.) domestic cannabis was 30 to 35 cents; for nontested, 20 to 25 cents a pound.

CARAWAY.

Caraway (*Carum carvi*) is a European biennial herb of the parsley family. It grows and fruits well over a considerable portion of the United States, especially in the North and Northwest, but its cultivation in this country seems never to have assumed commercial proportions. The seeds are used medicinally, but are mainly utilized for flavoring cakes, confectionery, and similar products. On distillation with steam, the seeds yield an aromatic oil, which is more used in medicine than the seed itself.

Soil of a somewhat clayey nature and containing a fair proportion of humus and available plant food is particularly suited to caraway, but the plant generally grows well in any good upland soil which will produce fair crops of corn or potatoes. Seeds should be sown in early spring in drills about 16 inches apart, and from 6 to 8 pounds of seed are sown to the acre. Frequent shallow cultivation throughout both growing seasons is desirable in order to keep the soil mellow and free from weeds, as a weedy crop at harvest time usually means a product inferior in quality.

As soon as the oldest seeds ripen, which is usually in June of the second year, the crop should be harvested. The plants may be cut with a mower and should be left in the swath until they have lost most of their moisture, when they may be built up into small cocks, or they may be brought in from the field and the curing finished in a barn loft. If on handling in the field the seeds shatter extensively, the crop should be brought in in tight wagons. When drying is finished the seeds are thrashed out, cleaned, and stored in bags which contain about 100 pounds each.

Returns from experimental areas indicate that a yield of about 1,000 pounds of seed per acre may be expected. One hundred pounds of seed will usually yield 4 to 6 pounds of oil. The average annual importation of caraway seed for several years has been about 2,000,000 pounds, valued at about 9 cents a pound. The war reduced the annual importations of oil of caraway from 30,000 to 9,000 pounds and increased the value from 80 cents to about \$4.25 a pound.

CASCARA SAGRADA.

Cascara, or cascara sagrada (*Rhamnus purshiana*), is a small tree 20 to 30 feet high, native to the western part of the United States, and found most abundantly in a narrow belt along the Pacific slope from northern California to southern British Columbia. The bark from the trunk and branches is the source of the drug, for which there is a constant and steady demand.

Plantings which have been made in the Eastern States indicate that this tree may probably be grown along the Atlantic slope in the Piedmont or foothill belt from Pennsylvania to Georgia. The trees have been found to grow better in clay loam than in either sand or clay. Propagation from seed is easy, but the seeds should be planted in the fall soon after they ripen or stratified in sand until used, since germination is very poor if the seeds are allowed to become dry. The seeds are sown in a seed bed under shade in drills 8 inches apart and covered about 1 inch deep. The seedlings reach a height of 10 to 15 inches the first year, and in the following spring before the leaves appear they are set in the field 6 feet apart each way. It is advisable to cultivate frequently, in order to keep the weeds down and to maintain a shallow surface mulch.

If the trees are pruned properly, a crop of bark may be harvested each year without killing the whole tree, as is done in collecting the bark from wild trees. At the time of transplanting, the trees are cut back to a straight stem about a foot high, from which all except the four uppermost buds are removed. The branches which afterwards develop from these buds are later deprived of their lower side shoots, thus causing the tree to grow a head of four long, stout branches instead of a single straight trunk. When the trees are large enough to yield a crop of bark, the longest of the four branches is cut off early in the spring flush with the trunk and a new branch is allowed to grow in its place. This process may be repeated yearly, removing only the largest branches of each tree in any one season.

The bark on the cut-off branches is divided with a sharp knife into lengthwise strips of about an inch or two in width, which may be readily pulled off. It is then dried carefully at a low temperature in the shade and broken into small pieces to facilitate packing and handling.

The price paid to collectors for cascara bark, which before the war usually varied from 1 to 4 cents a pound, in June, 1920, was about 10 cents a pound. So long as a supply of the wild bark continues to be available it is doubtful whether cascara can be cultivated at a profit.

CASTOR BEANS.

The castor-oil plant or Palma Christi (*Ricinus communis*) is a robust perennial in tropical countries which becomes an annual in regions subject to frost. The seeds of this plant, called "castor beans" or "mole beans," yield the castor oil of commerce. Between 1860 and 1900, the castor bean was an important crop in certain sections of Oklahoma, Kansas, Missouri, and Illinois, but during recent years its culture has been practically abandoned in favor of crops which are easier to handle and more profitable.

For the commercial production of castor beans a warm climate and long growing season are necessary. If planted much farther north than St. Louis, Mo., or Washington, D. C., the crop is very likely to be caught by frost. In general, any fertile soil which produces good crops of cotton or corn is suitable for castor beans, but a very fertile soil favors the growth of the plant at the expense of seed production and early maturity. The land is prepared in much the same manner as for cotton or corn; that is, plowed, disked, and harrowed level before planting, which may be done by hand or with a corn planter with specially prepared plates. The seed should be planted early in the spring, as soon as the soil is warm but still moderately moist. The time of planting varies according to locality, but in general corresponds to that of cotton.

The seed is planted in hills at a depth of 1 to 2 inches. Toward the north, the rows are usually made 4 feet apart and the hills spaced 3 feet apart in the row. Farther south the rows should usually be made about 6 to 8 feet apart. On very light land the hills may be 4 feet apart in the row; on heavier land, 6 to 8 feet apart. As a general rule three seeds are planted to the hill, and not less than two should be planted. One bushel of medium-sized seed should plant from 5 to 6 acres. When the plants are from 4 to 6 inches tall, the weaker ones should be removed, leaving one plant in a hill.

The crop is cultivated similar to corn until the plants are large enough to shade the ground. In case the field becomes foul with weeds and grass, some hoeing may be necessary, but practically all the cultivation required can be done with a horse-drawn weeder. Some varieties in which the beans pop out when the hull is fully ripe are known locally as "poppers," and after the beans begin to ripen, the field must be gone over every few days and the ripe beans collected in order to avoid loss. Other varieties tend to retain the beans in the hull after they are ripe. The climate affects the popping of the beans, and a variety which shatters badly in one region may shatter very little when grown in another.

In harvesting, a common method is to cut off the spikes with a knife and collect them in large sacks. They are then hauled to a shelter of some kind and allowed to dry until the pods will crush easily. Various methods are used in thrashing castor beans. If the variety grown is one which "pops" or drops its seeds when they are ripe, the spikes are sometimes piled on a hard ground or plank floor fully exposed to the sun and furnished with sides of boards or cloth 6 to 8 feet high to catch the beans as they pop out. In some varieties mere drying does not cause the pods to open, and specially constructed machines have been used to remove the beans from the pods. After the beans have been thrashed or popped out, a fanning mill is used to separate the hulls, chaff, and dirt from the beans, which are then sacked and stored for market.

The yield varies greatly and will depend much upon cultural conditions, the season, the variety grown, and the care exercised in harvesting and thrashing the seeds. In Oklahoma the average yield of the popping varieties is said to be 8 to 10 bushels per acre. Yields up to 25 bushels per acre have been reported for favorable conditions.

For some years prior to the war the farm price for castor beans was about \$1 a bushel. Early in the war the increased demand for castor oil caused a sharp advance in the price of the beans, which has gradually declined. In June, 1920, the wholesale market quotation was about \$3 a bushel. The normal market requirement in the United States for castor beans is about 1,000,000 bushels annually, but during the last year of the war nearly 3,000,000 bushels were imported.

In the United States castor beans are used in quantity only by manufacturers of castor oil. In general, the equipment and operation of a castor-oil mill resembles that of a cottonseed-oil mill or linseed-oil mill, but special and expensive equipment is necessary for the proper extraction of the oil from castor beans. The best grade of oil is obtained from the beans by hydraulic pressure. An additional quantity of oil of lower grade is obtained by treating the press cake with naphtha or some other volatile solvent. The pomace resulting from the second extraction is used as a fertilizer for tobacco, corn, and other crops, but because of a poisonous principle can not be used for cattle feeding unless specially treated.

Owing to the heavy outlay required for the necessary machinery and the high cost of manufacture on a small scale, it has not been found profitable for the growers of castor beans to undertake the extraction of the oil.

The castor-oil plant is not known to be poisonous, and although the leaves are not relished by farm animals they are said to be used as fodder for cattle in India. Castor beans, however, contain a poisonous principle, and though harmless when handled, may cause serious if not fatal effects when eaten, especially in the case of small children. Care should be taken to prevent these beans from being accidentally mixed with the grain fed to animals, since many cases have been reported in which the death of horses has been due to eating feed in which they have become mixed.

CATNIP.

Catnip (*Nepeta cataria*) is a European perennial plant of the mint family, which frequently occurs in this country as a weed in gardens and about dwellings. It has long had a popular use as a domestic remedy. Both leaves and flowering tops find some demand in the crude-drug trade.

Catnip does well on almost any good soil, but thrives best on a well-drained and moderately rich garden loam. However, a more fragrant and attractive herb can be grown in sandy situations than in heavy soils. The plant may be propagated from seeds or by root division. The seed may be sown in rows either late in the fall or in early spring and covered lightly. Fall-sown seed usually gives a more even stand and a heavier growth of herb. When the plants have reached a height of 4 to 5 inches they should be thinned to stand from 12 to 16 inches apart in the rows. In some localities the field sowing of seed does not give good results, in which case plants may be started in a cold-frame and later transplanted to the field. Shallow cultivation will favor a vigorous growth of the herb.

The flowering tops are harvested when the plants are in full bloom and are dried in the shade to preserve their green color. In case the herb is grown in large quantity, it may be cut with a mowing machine, the cutter bar of which should be set high. The plants should lie in the swath until partially dry, and the curing may then be finished either in small cocks in the field or in the barn, care being taken to preserve the natural green color as far as possible.

Returns from experimental areas indicate that a yield of about 2,000 pounds of dried flowering tops per acre may be expected under good conditions. The herb must be carefully sorted and all the large or coarse stems removed, after which it may be made up for the market in bales of 100 to 300 pounds each. Prewar prices to collectors ranged from 2 to 4 cents a pound. The prices in June, 1920, for the herb were 5 cents; for the leaves, 10 cents; and for the leaves and flowers, 14 cents a pound.

CHAMOMILE. (See CAMOMILE.)

CONIUM.

Conium, or poison hemlock (*Conium maculatum*), is a large, poisonous European biennial plant of the parsley family, naturalized in the Northeastern States and in California. The full-grown but unripe seeds (fruits) and the leaves are used medicinally.

Conium is easily grown and has been found to thrive in both comparatively moist clay soil and in dry sandy loam. In rich, moist land it may easily become a troublesome weed. Conium grows readily from seed, which may be sown either in the fall or early in the spring in drills 2 or more feet apart. As soon as the seedlings can be distinguished in the row, cultivation similar to that given ordinary garden crops is begun. The plants usually blossom in the second year, and when the oldest seeds are full grown but still green in color the plants are harvested and the seed at once thrashed out and dried with the least possible exposure to the light. The small and undeveloped seed should be screened out and rejected and the good seed stored in containers that will exclude light and air. The leaves are collected when the plant is in flower, quickly dried in the sun, and stored in the same manner as the seed.

Estimated yields at the rate of 600 to 800 pounds of seed per acre have been obtained, but the yield is very uncertain, since the flowering plants are especially subject to the attacks of insects which destroy the crop of seed. The prewar prices as quoted in the wholesale drug markets ranged from 5 to 10 cents a pound for the seed and 5 to 6 cents for the leaves. The prices in June, 1920, for the seed were 35 to 36 cents, and for the leaves 25 to 26 cents a pound.

CORIANDER.

Coriander (*Coriandrum sativum*) is an Old World annual of the parsley family. For years the plant has been cultivated in gardens in the United States, and it is now reported as growing wild in many places. The aromatic seeds and the oil distilled from them have long been used medicinally. Both the seed and the oil are also used for flavoring confectionery and cordials and as a condiment in bread and cake.

Coriander grows well on almost any good soil, but thrives best on deep and fertile garden loam. The soil should be well prepared before planting, which should be done moderately early in the spring. For field cultivation the seed is sown in rows 3 feet apart, but if the cultivation is done by hand the distance between the rows may be reduced to 18 inches. The seed should be sown thickly in order to insure a good stand. When well up, the plants are thinned to stand 4 or 5 inches apart in the row. Cultivation should continue until the plants flower, which will be about two months from the time of planting.

When most of the seeds are ripe the plants are cut with a scythe or mower, preferably early in the morning while moist with dew, in order to avoid shattering the seed. The plants are partially cured in small cocks in the field, the drying being finished in a barn loft or under other suitable shelter, after which the seeds are thrashed out and cleaned.

The yield of seed is quite variable, but returns from experimental areas indicate that from 500 to 800 pounds per acre may be expected. Five hundred pounds of seed will usually yield from 1 to 5 pounds of oil, according to the localities where grown. The annual importation of coriander seed is about

1,400,000 pounds. The prewar price of the seed was about 3 cents a pound; in June, 1920, 3 to 4 cents. The wholesale price of the oil of coriander, which was \$5 to \$7 a pound before the war, in June, 1920, ranged from \$42 to \$45 a pound.

DANDELION.

Dandelion (*Taraxacum officinale*) is a well-known and troublesome perennial weed, occurring abundantly almost everywhere in this country except in the Southern States. It is frequently cultivated in market gardens for the leaves, which are used for greens or salads, but the root alone is used in medicine.

This plant will grow well in any good soil and has been successfully cultivated in the South, but in the colder parts of the country it may require slight mulching during the winter if the roots tend to heave out of the soil. The seeds, which are sown in the spring, are drilled in rows 18 inches apart and covered one-half inch deep. About 3 pounds of seeds should sow an acre. The seedlings are thinned to stand a foot apart in the row, and the crop should be well cultivated and kept free from weeds.

The roots are dug in the fall of the second season after planting the seed. They should be washed and may be dried whole, or, to facilitate handling and drying, they may be cut into pieces 3 to 6 inches long and the larger portions sliced. Under favorable conditions, yields at the rate of 1,000 to 1,500 pounds of dry roots per acre have been obtained from second-year plants. The prices usually offered collectors for the dry root before the war ranged from 4 to 10 cents a pound. The price in June, 1920, was about 16 cents. The quantity annually imported into this country varies from year to year, but averages about 40 tons.

A serious disadvantage attending the cultivation of this crop is the danger of seeding adjacent land with a very undesirable weed.

DIGITALIS.

Digitalis, or foxglove (*Digitalis purpurea*), is a fairly hardy European perennial, which has long been grown in flower gardens in this country as an ornamental plant. The leaves are used in medicine, those from plants of the second year's growth being required for the official drug.

Digitalis thrives in ordinary well-drained garden soils of open texture and reasonable fertility. Sowing the seed directly in the field occasionally gives good results, but is so often unsuccessful that it can not be recommended. The seeds are exceedingly small and do not germinate well except under the most favorable conditions. They should be mixed with sand, to insure even distribution in seeding, and sown as early as February in seed pans or flats in the greenhouses or in well-protected frames. When danger of frost is past the plants should be hardened off and transplanted to the field, where they may be set about a foot apart in rows spaced conveniently for cultivation.

The plants do not flower until the second year, and it is necessary to cultivate them frequently during the growing seasons of both the first and second year. In localities where the cold weather is severe it may be desirable to protect the plants during the first winter with a light mulch of straw or coarse farm-yard manure.

The plants usually flower in June of the second year, and the leaves may then be collected. They are carefully dried in the shade and should be stored in such a manner that they will not be exposed to light and moisture. The results of experiments indicate that yields of 450 to 600 pounds of dry leaves per acre may be obtained under favorable conditions. In considering digitalis

culture it should be borne in mind that the crop occupies the soil for the greater part of two seasons and demands even closer attention than many truck or garden crops.

In 1919 small areas of cultivated digitalis, ranging from one-half to 1 acre in extent, were harvested in Pennsylvania, South Carolina, Washington, California, and some other States. Several tons of digitalis leaves were also collected from plants of wild growth in the general region of the Coast Range of mountains on the Pacific coast. Digitalis is of great medicinal importance, but on account of its potency is administered in very small quantities; consequently, a few thousand pounds is sufficient to meet the annual market requirements. Before the war the price for digitalis leaves averaged about 15 cents a pound; in June, 1920, it was about 35 cents a pound.

DILL.

Dill (*Anethum graveolens*) is an Old World annual or biennial herb of the parsley family. Although it is a native of southern Europe, it is hardy plant and may be grown in a much cooler climate if given a warm situation and a well-drained soil. The leaves are used for seasoning, and the seeds (fruits), which are greatly valued for flavoring pickles, are used as a condiment and occasionally in medicine. A volatile oil distilled from the seeds is used chiefly for perfuming soap.

Dill is preferably grown as an annual plant, in which case the seed should be sown about one-half inch deep very early in the spring in drills a foot apart. A half ounce of seed is sufficient to sow 150 feet of drill, and at this rate a pound should sow an acre. When sown in the field the rows may be 15 to 18 inches apart, and the seedlings should be thinned to stand about a foot apart in the row. The most favorable soil is a well-prepared loam, but the plants grow well in any good garden soil. Frequent cultivation and freedom from weeds are essential for good results.

Early in the fall, as soon as some of the older seeds are ripe, the plants are mowed and built up into small cocks in the field, or, if sufficiently dry, the seeds may be thrashed out at once. In very dry weather it is preferable to mow the plants early in the morning while they are moist with dew, in order to avoid shattering the seed. In case the seed is very ripe, it is well to cut the plants high and to place the tops directly on large canvas sheets, in which they may be brought from the field. After thrashing, the seeds should be spread out in a thin layer and turned frequently until thoroughly dry, since they tend to become musty if closely stored before all the moisture has been removed.

The yield of dill seed is quite variable and is much influenced by climatic conditions. From 500 to 700 pounds of seed per acre is considered a good yield. The wholesale price in June, 1920, ranged from 8 to 11 cents a pound.

ECHINACEA.

Echinacea (*Brauneria angustifolia*, fig. 6) is a native perennial plant of the aster family found on the prairies of the Middle West, occurring most abundantly in Nebraska and Kansas. The roots of the plant are used medicinally.

This plant has been found to do well under cultivation in moderately rich and well-drained loam. It grows fairly well from seeds, which may be collected when ripe and kept dry until ready for use. Plants should be started in a well-prepared seed bed by sowing the seeds thinly in drills about 8 inches apart.

The plants develop slowly and may be left in the seed bed for two years and then transplanted to the field in the spring and set about 18 inches apart in rows. Thorough cultivation is essential for the best results. The roots do not reach a marketable size under three or four years from the time of sowing the seed. They are harvested in the fall, freed from any adhering soil, and dried either in the open air or by means of low artificial heat.



FIG. 6.—Echinacea (*Brauneria angustifolia*).

Echinacea has not been cultivated on a scale large enough to give satisfactory data on the probable yield. The prewar wholesale price ranged from 22 to 60 cents a pound; in June, 1920, it was 60 to 65 cents a pound.

ELECAMPANE.

Elecampane (*Inula helenium*) is a European perennial plant of the aster family, now growing wild along roadsides and in fields throughout the northeastern part of the United States. The root is used in medicine.

Elecampane will grow in almost any soil, but thrives best in deep clay loam well supplied with moisture. The ground on which this plant is to be grown should be deeply plowed and thoroughly prepared before planting. It is preferable to use divisions of old roots for propagation, and these should be set in the fall about 18 inches apart in rows 3 feet apart. Plants may also be grown from seeds, which may be sown in the spring in seed beds and the seedlings transplanted later to the field and set in the same manner as the root divisions. Plants grown from seed do not flower the first year. Cultivation should be sufficient to keep the soil in good condition and free from weeds.

The roots are dug in the fall of the second year, thoroughly cleaned, sliced, and dried in the shade. The available data on yield indicate that a ton or more of dry root per acre may be expected. The price to producers usually ranges from 3 to 6 cents a pound. Upward of 50,000 pounds of elecampane root were annually imported into this country prior to the war.

FENNEL.

Fennel (*Foeniculum vulgare*) is an Old World perennial plant of the parsley family, occasionally cultivated as a garden herb in the United States. The aromatic seeds (fruits) are used in medicine and for flavoring. The oil distilled from the seeds is used in perfumery and for scenting soaps.

Fennel grows wild in mild climates in almost any good soil and thrives in rich, well-drained loams containing lime. It is propagated from seeds, which may be sown in the open as soon as the ground is ready for planting in the spring. The seed is sown thickly in drills 2 to 3 feet apart and covered lightly. From 4 to 5 pounds of seed should sow an acre. When well established the plants may be thinned to stand 12 to 15 inches apart in the row. Plants may also be started in a seed bed from seed sown either in drills 6 inches apart or

broadcast. When the seedlings are three or four inches high they are transplanted to the field and set 12 to 15 inches apart in rows. The cultivation is the same as for ordinary garden crops.

Frequently, very little seed is formed the first year, but full crops may be expected for one or two succeeding years. The seed is gathered in the fall before it is fully ripe and may be harvested like anise or coriander. A yield of 600 to 800 pounds of seed per acre may be expected. During recent years about 275,000 pounds of seed have been imported annually. Owing to the war, prices for the seed and oil have about doubled. The prices in June, 1920, for the seed were 11 to 12 cents a pound; for the oil, \$2.75 to \$3 a pound.

GENTIAN.

The common or yellow gentian (*Gentiana lutea*) is the only species recognized in American medicine, although the roots of several other species are found in the drug trade. The plant grows wild in the mountains of central and southern Europe, but it has proved very poorly adapted for cultivation in situations beyond its natural range. For its best development under cultivation, partial shade, similar to that required by ginseng and goldenseal, seems necessary. The plants are said to flower when about 6 years old; hence, several years must elapse after sowing the seed before the roots reach a marketable size. Apparently there have been no attempts to cultivate gentian commercially in this country. The prewar wholesale price of imported gentian root ranged from 4½ to 8 cents a pound. The price in June, 1920, was 12 to 13 cents a pound.

GINSENG.

Ginseng (*Panax quinquefolium*) is a fleshy-rooted herbaceous plant native to this country and formerly of frequent occurrence in shady, well-drained situations in hardwood forests from Maine to Minnesota and southward to the mountains of Georgia and the Carolinas. It has long been valued by the Chinese for medicinal use, though rarely credited with curative properties by natives of other countries. When placed under cultural conditions, ginseng should be shielded from direct sunlight by the shade of trees or by lath sheds. The soil should be fairly light and well fertilized with woods earth, rotted leaves, or fine raw bone meal, the latter applied at the rate of 1 pound to each square yard. Seed should be planted in the spring as early as the soil can be worked to advantage, placed 6 inches apart each way in the permanent beds or 2 by 6 inches in seed beds, and the seedlings transplanted to stand 6 to 8 inches apart when 2 years old. Only cracked or partially germinated seed should be used.

Ginseng needs little cultivation, but the beds should at all times be kept free from weeds and grass and the surface of the soil slightly stirred whenever it shows signs of caking. A winter mulch over the crowns is usually essential, but it should not be applied until freezing weather is imminent and should be removed in the spring before the first shoots come through the soil.

The roots do not reach marketable size until about the fifth or sixth year from seed. When dug they should be carefully washed or shaken free from all adhering soil, but not scraped. Curing is best effected in a well-ventilated room heated to about 90° F. Nearly a month is required to properly cure the larger roots, and great care must be taken in order to prevent molding or souring. Overheating must also be avoided. When well cured the roots should be stored

in a dry, airy place until ready for sale. A market may be found with the wholesale drug dealers, some of whom make a specialty of buying ginseng root for export.

The price of cultivated ginseng roots, as quoted in wholesale drug lists, ranges from \$1.50 to \$8 a pound, according to quality and freedom from disease.

Further details respecting the culture of ginseng are given in a Farmers' Bulletin now in press, entitled "Ginseng Culture," and in Farmers' Bulletin 736, entitled "Ginseng Diseases and Their Control."

GOLDENSEAL.

Goldenseal (*Hydrastis canadensis*) is a native perennial, formerly quite abundant in open woodlands having ample shade, natural drainage, and an abundance of leaf mold. Its range is from southern New York and Ontario west to Minnesota and south to Georgia and Kentucky.

When grown under cultivation the soil should be well fertilized, preferably by decaying vegetable matter, such as woods soil and rotting forest leaves, which should be well worked in to a depth of 10 inches or more. Raw bone meal and cottonseed meal are also favorable in their action. Seed may be sown in October in a well-prepared seed bed. It may be scattered broadcast or dropped one-half inch apart and covered with fine leaf mold to the depth of 1 inch. During the winter the seed bed should be protected with burlap or fertilizer sacks, and should also be guarded against encroachment of moles or mice. Plants may be set 6 to 8 inches apart each way and the rootstocks covered to a depth of about 2 inches. For satisfactory growth goldenseal requires about 75 per cent of shade during the summer, which should be provided by a lath shade or by cloth, brush, or vines. The soil should be kept free from weeds and the plants liberally watered throughout the growing season, but good drainage is necessary, since goldenseal does not thrive in boggy ground.

Under favorable conditions goldenseal reaches its best development in about five years from seed, or in a year or two less when grown from root buds or by divisions of the rootstocks. The root is dug in the autumn after the tops have withered. They are washed clean of all soil, sticks, etc., and dried on lath screens in an airy place in mild sunlight or partial shade, or indoors on a clean, dry floor. When dried in the open they should be protected from rain and dew. The cured root is kept in loose masses until marketed, since close packing may cause attacks of mold. The dried leaves and stems of goldenseal, commonly known as "seal herb," are also a marketable product.

The prices in June, 1920, ranged from \$5 to \$6 a pound for the roots and from 40 to 70 cents a pound for the herb.

HENBANE.

Henbane (*Hyoscyamus niger*) is a poisonous annual or biennial herb of the nightshade family, introduced into this country from Europe and occasionally found as a weed in a number of the Northern States. The leaves, flowering tops, and sometimes the seeds are used medicinally.

Henbane is propagated from seeds, but when these are sown in the open field germination is uncertain, and a very poor stand or total failure is a frequent result. Germination is usually much more certain when the seeds are sown under glass, but the plants do not readily stand transplanting and often die after they are set in the open. Very good results have been secured by sowing the seed in small pots under glass in January, transferring the seedlings to 3-inch pots in March, and transplanting in May to the field, where the plants may be set at least 15 inches apart in rows. In handling the plants care should

be taken to disturb the soil about the roots as little as possible. The soil requirements and method of cultivation are practically the same as for belladonna.

The leaves of henbane usually suffer severely from attacks of the potato beetle, especially during the first year, and the crop is very likely to be destroyed if grown within the range of this insect.

Ordinarily the plants blossom about August of the second year and die after ripening their seed, but individual plants started early frequently bloom and set seed the first year. The leaves and flowering tops are collected when the plants are in full bloom and are carefully dried in the shade.

The American crop of henbane has never much exceeded 10 acres. The yield under favorable conditions is estimated at about 6,000 pounds per acre. The wholesale price in June, 1920, was 35 to 38 cents a pound.

HOREHOUND.

Horehound (*Marrubium vulgare*) is a hardy perennial herb of the mint family, which occurs as a common weed in many places in the United States, especially on the Pacific coast, where it threatens to become a pest. The leaves and flowering tops find some demand as a crude drug. Their greatest use, however, is in the manufacture of candy, although they are sometimes employed for seasoning.

Horehound grows well in almost any soil and thrives in light, dry soils lacking in fertility. It grows readily from seeds, which are usually sown in drills early in the spring and covered with about an inch of soil. Plants may also be started in coldframes, either from seed or cuttings, and later transplanted to the field. Propagation may also be effected by division of old plants. Plants may stand 6, 12, or 18 inches apart in the row; those which stand close together will have small stems, and hence will yield a crop of finer quality.

The plants are harvested just before flowering and should be cured in the shade in order to preserve the green color. If the stems are small, the plants may be cut close to the ground with a scythe, or with a mower if the area is large. In case the plants are tall and large they must be cut some distance above the ground and all coarse stems removed to make the herb suitable for marketing.

Yields at the rate of 2,000 pounds of dry herb per acre have been obtained. The prewar wholesale prices for the herb ranged from 5 to 8 cents a pound. The price in June, 1920, was 15 to 16 cents. The annual importation of horehound varies from year to year, sometimes reaching 60 to 70 tons.

INSECT-POWDER FLOWERS.

Insect flowers, from which pyrethrum or insect powder is prepared, are produced by several species of plants of the aster family which occur wild in the eastern Mediterranean region, where they are also cultivated.

The species here considered (*Chrysanthemum* [*Pyrethrum*] *cinerariaefolium*) has been cultivated commercially in California for the production of insect powder. This species seems to thrive best in warm situations and should grow well in any good soil which is well drained and not too heavy. The seeds may be sown directly in the field, either early in the spring or in the fall, but it is preferable to start the plants in coldframes or well-prepared seed beds and transplant them to the field. The seed is mixed with sand and sown broadcast on the surface of the bed and lightly covered with a rake. Water should be used sparingly on the seed bed, since the young seedlings and even mature

plants are easily killed by a wet soil. When the seedlings are about a month old they are transplanted, during damp weather if possible, and set 8 to 12 inches apart in rows 3 to 4 feet apart. Old plants may also be divided and used for propagation. The plants should be well cultivated during the growing season and will yield flowers for several years if they are well cared for. The fertility of the soil is maintained by the application of fertilizers.

The time of harvesting varies from June to September, according to locality. The flower heads are gathered just as they open and may be collected by hand or by means of a flower picker. They are dried, preferably in the shade, on canvas sheets about 15 feet square, on which they are spread in a thin layer and turned two or three times a day until dry.

The average yield of dried flowers appears to be about 450 pounds per acre. The wholesale price for these flowers in June, 1920, was 85 to 90 cents a pound, which is from three to four times the prewar price.

LARKSPUR.

The larkspur of the crude-drug trade is an annual plant (*Delphinium consolida*), native of southern Europe, which has long been cultivated in this country as an ornamental and is now occasionally found growing wild. Another species of larkspur (*Delphinium urceolatum*) is native to this country and is said to have properties very similar to those of the European species. Larkspur seed is now used chiefly in remedies for external parasites.

These larkspurs thrive best in a rich sandy or gravelly soil. In heavy soils they are likely to suffer from root-rot, which materially reduces the yield. A rather dry climate is suitable for plants of this character. They do not bear transplanting well and seeds should be sown in the fall or very early in the spring where the plants are to stand. The soil should be well fined and the seed thinly sown in drills spaced according to the method of cultivation to be used. When up, the plants should be thinned to stand 8 inches or more apart in the rows. The necessary cultivation consists in keeping the soil between the rows and about the plants mellow and free from weeds during the growing season.

When the seed capsules are fairly ripe, the seed is harvested by collecting the tops, which should be cut before the seed capsules have become so brittle as to risk the loss of seed by shattering and which can be handled best in the early morning while damp and pliable. They should be cured in a well-ventilated place, sheltered from rain, and when thoroughly dry may be thrashed out and cleaned.

The wholesale price now quoted for larkspur seed is between 32 and 35 cents a pound.

The seed of a European species of larkspur (*Delphinium staphisagria*), commonly called stavesacre, possesses medicinal properties and is recognized as an official drug. The wholesale price for stavesacre seed in June, 1920, was about 30 cents a pound.

LAVENDER.

The true lavender (*Lavandula vera*) is a small shrubby plant of the mint family, native to southern Europe, and widely cultivated for its fragrant flowers and for the oil distilled from the fresh flowering tops.

Lavender thrives best in light and rather dry soils well supplied with lime, but may be grown in almost any well-drained loam. On low or wet land it is almost certain to winterkill. The plant is not easily grown from seed, but may be readily propagated from cuttings or by division. In cold climates the plants

must be well protected during the winter, or they may be carried over in a greenhouse or coldframe. Early in the spring the plants or rooted cuttings are set in well-prepared soil, 12 to 15 inches apart in rows spaced to suit the cultivation intended. Frequent and thorough cultivation is desirable.

Not many blooms can be cut the first year, but full crops may be expected for each of the three following years, after which it will be best to start new plantings. The flowering tops are harvested when they are in full bloom, and if used for the production of oil are distilled at once without drying. If the dry flowers are wanted, the tops are carefully dried in the shade and the flowers later stripped from the stems by hand.

On ordinary soil, yields of 600 to 1,200 pounds per acre of fresh flowering tops have been obtained. The dry weight is about four-fifths of the green weight. The yield of oil varies widely, but from 12 to 15 pounds per acre may be expected under good conditions. The wholesale prices in June, 1920, were about as follows: For "ordinary" flowers, from 18 to 24 cents a pound; for "select" flowers, from 30 to 35 cents a pound; for oil of lavender flowers, \$11 to \$12 a pound.

LICORICE.

Licorice (*Glycyrrhiza glabra*) is an Old World plant, the culture of which has not succeeded commercially in this country, although the plant grows well in the arid Southwest and in California, where in some localities it threatens to become a weed. Licorice is used to some extent in medicine, and is said to be much in demand by manufacturers of tobacco.

Licorice is a fairly hardy plant, but it thrives best in warm regions, where the season is sufficiently long to promote strong growth. Plants may be grown from seed, but propagation by means of cuttings made from the younger parts of the Rhizome, or so-called root, usually gives best results. The cuttings are set perpendicularly in deep, moist, sandy, or loamy soil, and should stand about 18 inches apart in rows so spaced as to allow for the cultivation necessary to keep the soil mellow and free from weeds.

The yield under good culture is said to average about 5,000 pounds of dry root per acre at the end of every third year. The relatively low price at which the imported root can usually be obtained has so far prevented the development of commercial licorice growing in this country. Nearly 100,000,000 pounds of licorice root and an average of about 600,000 pounds of licorice paste are annually imported into the United States when trade conditions are normal.

Prewar prices for the imported root usually ranged from 4 to 5½ cents a pound in bales. The price in June, 1920, was 13 to 14 cents.

LOBELIA.

Lobelia (*Lobelia inflata*) is a native poisonous annual plant, occurring generally in open woods and pastures, but is most abundant in the States east of the Mississippi River. The leaves, tops, and seeds are used medicinally.

This plant thrives under cultivation in a rather rich, moist loam, and grows well either in the open or in partial shade. It grows readily from seeds, which are very small and must be sown on soil which has been well fined and exceptionally well prepared. The seeds are sown either in the fall or spring in rows 2 feet apart. It is best not to cover the seeds but to sow them on the surface of the soil, which is then firmed with a float or by resting a board over the row and walking upon it. Fall planting usually gives a better stand and a heavier crop. Shallow cultivation should be given until the plants begin to flower.

Lobelia is harvested when in full flower or as soon as some of the older seed pods are full grown. The plants may be cut with a mower if the cutter bar is set high enough to avoid including the large stems. The herb should be dried in the shade, in order to preserve the green color.

Small areas have given yields at the rate of 1,000 pounds of dry herb per acre. The prewar price paid to collectors for the dried herb was about 3 cents a pound. The prices in June, 1920, were, for the herb, 20 cents; for the seed, 75 cents a pound.

LOVAGE.

Lovage (*Levisticum officinale*) is a perennial plant of the parsley family, introduced into this country from Europe as a garden plant and now grown as a crop in certain localities in New England and the West. The root has long been supposed to have medicinal properties and is in some demand in the drug trade. The flowering tops yield a volatile oil, for which, however, there is little demand. The seeds are used for flavoring confectionery and the leaf stems are sometimes blanched, like celery, and eaten as a salad.

Lovage is propagated by division or from seeds. The seeds may be planted in the fall in drills 18 inches apart or sown in early spring in a hotbed, greenhouse, or well-prepared seed bed in a sheltered portion of the garden. They should be covered very lightly with sand or fine sifted soil, and in order to prevent the soil from drying out before the seeds germinate it is advisable to spread old burlap or sacking over the bed. The sacking may be sprinkled occasionally if the weather is dry and should be removed when the first seedlings break the soil. The plants should reach a size suitable for transplanting by the end of May, when they may be set at intervals of 8 inches in rows far enough apart for convenient cultivation. Lovage grows well in almost any deep, well-drained soil, such as will produce a fair crop of corn or potatoes, and is benefited by the liberal use of fertilizer, although heavy applications of manure tend to produce excessive top growth.

The roots may be dug in October of the second or third year after setting the plants. Numerous offsets will generally be found, and if these have good roots they may be used to renew the plantation without recourse to seed. Such shoots should at once be reset at the usual distances apart. The freshly dug roots should be well washed, cut into slices about one-half inch thick, and carefully dried. If necessary, artificial heat, not to exceed 125° F., may be used to hasten drying.

Returns from experimental areas indicate that a yield of about 1,000 pounds of dried root to the acre may be expected under good conditions every third year. The prices quoted for American lovage root in the wholesale drug markets range from 45 cents to \$1 a pound, according to demand and quality. Producers, however, usually receive much less than the wholesale price.

MELISSA.

Melissa, balm, or lemon balm (*Melissa officinalis*), is a perennial herb of the mint family, native to southern Europe. In this country it has long been cultivated in gardens, from which it has escaped and now grows wild in many places in the eastern United States. The leaves of balm are widely used for culinary flavoring, and the leaves and flowering tops are used in medicine. The volatile oil distilled from the plant is said to be used in perfumery and also for flavoring.

Balm grows readily on any good garden soil and is easily propagated from seeds, cuttings, or by division. The seeds may be sown in the open early in the spring, but owing to their small size it is best to sow them in shallow flats in a greenhouse or in a hotbed. The soil should be well fined and the seeds sown thinly on the surface of the soil, which is then firmed with a float or a small board. When well up, the seedlings should be transferred to deeper flats, and when 4 or 5 inches high they may be transplanted to the open and set about a foot apart in rows spaced to suit the cultivation to be given. Cultivation should be frequent and sufficient to keep the soil about the plants mellow and free from weeds.

When the plants are in full flower the crop can be cut with a scythe, or with a mower if the herb is to be used for distillation. For preparing the crude drug only the flowering tops are collected, the coarse, stemmy portions of the herb being rejected. The leaves and tops are dried in the shade in order to preserve the green color.

Yields at the rate of about 1,800 pounds of dry herb per acre have been obtained, but if only the flowering tops are collected the yield will be very materially less. The prewar price paid to collectors for the leaves and tops ranged from 3 to 4 cents a pound. In June, 1920, the price for the leaves was 15 cents a pound.

ORRIS.

Orris (*Iris florentina*) is a perennial, native to southern Europe, and is cultivated chiefly in Italy for its fragrant rootstocks, which yield the orris of commerce. The plant grows well in a variety of soils and flourishes in a rich, moist loam, but roots which are grown in rather dry, gravelly soil appear to be the most fragrant. Orris is readily propagated by division of the old plants, which may be set either in the spring or fall about a foot apart in rows spaced conveniently for cultivation.

Since harvesting usually takes place only once in three years, the use of the land is required for that length of time in order to obtain one crop. After the roots are dug they are peeled and dried in the open air. The desired fragrance does not develop until after the dry roots have been stored for a number of months, during which time they are especially liable to the attacks of insects.

The yield is from 5 to 6 tons of dry root per acre. The average annual importation of orris is normally about 500,000 pounds. The wholesale prices, which before the war ranged from 6 to 10 cents, in June, 1920, were 14 to 15 cents a pound. The outlook for a profitable orris industry in this country does not appear promising, and it does not seem advisable for any considerable number of persons to undertake the growing of this crop.

PARSLEY.

Parsley (*Petroselinum sativum*) is a biennial herb grown everywhere in gardens for use in garnishing and seasoning. All parts of the plant contain a volatile oil, that from the seed being especially rich in a constituent known as apiol, or "parsley camphor," which is still used to some extent in medicine. In the crude-drug trade there is a small demand for the root, leaves, and seed.

A rich and rather moist soil is desirable for the growing of parsley. The seeds germinate slowly and are frequently sown early in the spring in cold frames or seed beds, from which the young plants may be removed later and set in the open in rows 12 or more inches apart and about 6 inches apart in the row. When the leaves are fully grown they may be collected and dried in the

usual manner. The plants flower in the second year, and as soon as the seed is ripe it is harvested and carefully dried. At the end of the second growing season, late in October, the root may be dug and should be well washed and carefully dried. Artificial heat may be used in drying if necessary.

On small areas yields of seed at the rate of about 185 pounds per acre have been obtained. During the past few years the wholesale price of the seed has varied from 10 to 70 cents a pound, according to demand and season. From 15 to 50 pounds of seed are required to yield 1 pound of the oil, which in June, 1920, was quoted at \$6.50 to \$7 a pound.

PENNYROYAL.

Pennyroyal (*Hedeoma pulegioides*) is an annual plant, flowering from June to October, and is found in dry soils from Nova Scotia and Quebec to Dakota and southward. Both the dry herb and the oil obtained therefrom by steam distillation form marketable products.

Pennyroyal grows well on average upland soils and is frequently abundant on sandy or gravelly slopes. In field planting the seeds should be sown in rows in the fall and covered not to exceed one-quarter of an inch, since they rarely germinate if planted at a greater depth. The plants come up early in the spring, and to secure the best results clean cultivation and freedom from weeds are essential, as with all cultivated crops.

Early in the summer, when the plants are in full flower, they may be mowed. To prepare the herb for market the plants are dried, preferably in the shade, and carefully packed immediately after drying. All the large stems should be removed in order to improve the quality of the product. The herb should be marketed promptly, since it deteriorates with age. For the production of the volatile oil, the plants should be harvested when in full flower and distilled without drying.

Returns from experimental areas indicate that a yield of about 1,200 pounds of dry herb per acre may be expected. The yield of oil varies from 15 to 30 pounds per acre. The price paid for the dry herb usually ranges from 1 to 2 cents a pound. The wholesale price of the oil ranges from about \$1 to \$2 a pound.

PEPPERMINT.

Peppermint (*Mentha piperita*) is a perennial of the mint family, frequently found growing wild in moist situations throughout the eastern half of the United States. It is cultivated on a commercial scale, chiefly on the muck lands of southern Michigan and northern Indiana. The volatile oil forms the principal marketable product, but there is some demand in the crude-drug trade for the dried leaves and flowering tops.

Peppermint is propagated from "roots," or runners, which should be set in an almost continuous row in furrows about 3 feet apart and covered to a depth of about 3 inches. It can be grown on any land that will produce good crops of corn, but is most successful on the muck lands of reclaimed swamps. On uplands it soon exhausts the soil and will not do well for more than two or three seasons without the rotation of crops. On rich muck lands it will grow for a number of years, the soil being plowed after the crop is harvested and the runners turned in to form a new growth the succeeding year. It is essential that the ground be kept free from weeds, since their presence in the crop at harvest would seriously injure the quality of the oil.

When peppermint is grown on reclaimed swamps or muck lands fertilizers are rarely needed, but on uplands it is well to plow in 12 or more tons per acre

of rotted stable manure before planting. Similar applications may be made between the rows in early spring and plowed in as the land shows signs of exhaustion. Commercial truck or potato fertilizers cultivated in between the rows at the rate of 600 pounds to the acre have proved useful in keeping up fertility, but manure is to be preferred, as it provides humus or vegetable matter as well as increases the fertility.

Harvesting is begun in July or August, when the plants are in full bloom. The herb is cut and cured like hay, and when fairly well dried is placed in large vats or stills having a capacity of from 1 to 3 tons of dry herb and distilled with steam to obtain the volatile oil. The yield of oil is exceedingly variable, but on lands well suited for the production of peppermint the average yield is not far from 30 pounds per acre. The annual production of peppermint oil in the United States is about 300,000 pounds. For many years before the war the price of the oil varied from year to year, but averaged about \$2.50 a pound. There is some demand for the dried leaves and tops, for which 6 to 15 cents a pound was paid to collectors in June, 1920.

For further information on the growing of peppermint, see Farmers' Bulletin 694, entitled "The Cultivation of Peppermint and Spearmint."

PINKROOT.

Pinkroot (*Spigelia marilandica*, fig. 7) is a native perennial herb occurring in rich open woods from New Jersey to Wisconsin and south to Florida and Texas. The root is an official drug, the use of which has declined in recent years, apparently on account of the extent to which pinkroot has been adulterated with the worthless roots of another plant known as East Tennessee pinkroot. Prospective growers of pinkroot should obtain seeds or roots for planting from thoroughly reliable sources only.

Pinkroot makes a vigorous growth under conditions suitable for growing ginseng or goldenseal, and partial shade is usually necessary, although if given a rich, moist, loamy soil it may be grown without shade in situations not too hot and dry. It is propagated either from seeds or from divisions of old roots. It is best to sow the seeds as soon as they are ripe, but if mixed with moist sand and kept in a cool place sowing may be deferred until fall or the following spring. The seeds are sown in drills 6 inches apart in well-prepared seed beds, and in the spring, when the young plants are a few inches high, they are set about a foot apart each way in the permanent beds. The old roots are divided when dormant, and each division should consist of a portion of the root with one or more buds and a number of the small rootlets. They are set in the same manner as the seedlings. Thorough cultivation and freedom from weeds are essential for good results.

The roots usually attain a marketable size in three years, but will give a heavier yield at the end of the fourth or fifth year. They are harvested in the fall, and after the tops are cut off the roots are well washed and thoroughly



FIG. 7.—Pinkroot (*Spigelia marilandica*).

dried. Little can be said regarding yield, but returns from small areas indicate that a bed 4 by 30 feet will yield from 10 to 12 pounds of dry root in four years. The prices paid to collectors of pinkroot before the war ranged from 15 to 30 cents a pound. The price in June, 1920, was about 60 cents a pound.

POKEWEED.

Pokeweed (*Phytolacca americana*) is a native plant of frequent occurrence in moist, rich soil along fences and in uncultivated land throughout the eastern half of the United States. The root, which is perennial, sends up large annual stems, sometimes attaining a height of 8 or 9 feet. This plant bears numerous long clusters of smooth, shining purple berries, very attractive in appearance, but the seeds are said to be poisonous. Both the root and the berries are used in medicine.

Pokeweed thrives in deep, rich soils well supplied with moisture and may be readily grown from seed sown early in the spring in rows 4 feet apart and barely covered. The seedlings may be thinned to stand about 3 feet apart in the rows. Cultivation should be shallow, though frequent. The plant develops a long, thick, and fleshy root, which when old is not easily harvested and may have to be dug by hand. If the roots of plants grown from seed are harvested at the end of the first year, they may be turned out by means of a deep-running plow without great difficulty. As soon as they are dug the roots are cleaned by washing and are usually cut into lengthwise or transverse slices for drying. They should be thoroughly dried, and if a large quantity is to be handled the use of artificial heat will be found desirable.

A yield of about 600 pounds of dry root per acre may be expected at the end of the first year, or three or four times as much from plants of the second year's growth. In the second year several hundred pounds of berries may also be obtained from 1 acre.

Before the war, collectors received from 2 to 3 cents a pound for the roots and berries. The price in June, 1920, for the dry, cut root was about 6 cents and for the dry berries 15 cents a pound. Apparently there is but a small demand for either of these products.

SAFFLOWER.

Safflower, American saffron, or false saffron (*Carthamus tinctorius*) is a hardy Old World annual of the aster family, cultivated in gardens in this country for its flowers, which are used in coloring or for flavoring, and sometimes as a substitute for the true saffron.

Safflower grows well on moist soils and may be readily propagated from seeds sown in the open early in the spring. The soil should be fine and mellow, and the seeds sown an inch or more apart in drills and well covered. About three weeks from the time of sowing the seed the plants will be well started, and cultivation should begin at once and be continued until the flower buds form. The plants bloom in July or August, when harvesting may begin. Only the florets are collected, and, since these must be removed by hand, harvesting is slow and expensive. The plants continue to blossom for several weeks, and the florets must be harvested almost daily. It is best to collect them early in the morning and to dry them in the shade on trays having muslin bottoms. The florets should be turned daily until thoroughly dry and then stored in tin containers.

The yield is estimated at 125 to 150 pounds of dry florets per acre. The price for safflower is variable and ranges from 19 to 60 cents a pound.

SAFFRON.

The true saffron (*Crocus sativus*) is a low-growing, fall-blooming, bulbous plant of the iris family, native to southern Europe, where it is cultivated commercially. It was formerly grown as a small garden crop in some localities in this country, chiefly in Lancaster and Lebanon Counties, Pa. The stigmas of the flowers form the saffron of commerce. Saffron is used in cookery and for coloring confectionery, and was formerly widely used in medicine.

A rich, well-drained garden soil favors a vigorous growth of the plant, but a better quality of saffron is secured on land of medium fertility. It is propagated from bulbs (corms), which may be planted in August about 6 inches apart each way and 6 inches deep in well-prepared soil. When grown on a large scale the bulbs are often set late in the spring. The ground is laid off in rows about 20 inches apart, and a furrow 6 to 8 inches deep is opened for each row. In this furrow the bulbs are set in two parallel rows about 4 inches apart and about 2 inches apart in the row. The furrows are then filled and the surface of the soil brought to a uniform level. Thorough cultivation and freedom from weeds are essential for good results.

The purplish blossoms usually appear about October, but the main leaf growth of the plant is made in the following spring. The bulbs may remain undisturbed for three or four years, or they may be taken up yearly and the clusters divided. All unsound bulbs should be rejected, as they are often attacked by a fungus which readily spreads to the sound bulbs, causing them to rot. During the blossoming period, which frequently lasts from two to three weeks, the flowers are collected daily just as they open. The orange-colored stigmas are then removed from the flowers, either by pulling them out or by cutting them off with the finger nail, after which the flowers are thrown away. The stigmas are dried immediately, a common method being to spread them in a thin layer on a sieve which is suspended over a low fire. When fully dry they are placed in linen bags and stored in a dry place.

The yield of saffron is variously estimated at from 10 to 30 pounds per acre, according to the situation where it is grown. About 50,000 flowers are required to produce a pound of dry saffron; consequently, the amount of hand labor involved in removing the stigmas is quite large. The price usually received for saffron in normal times is not far from \$8 a pound, but the prices in June, 1920, ranged from \$14 to \$15 a pound. Owing to the high cost of production, it is not thought probable that saffron culture would prove profitable in the United States.

SAGE.

The common sage plant (*Salvia officinalis*) is a hardy perennial of the mint family, widely cultivated in gardens, and when once established it persists for several years. The leaves are used extensively for seasoning meats and soups, and a tea made from them is an old household remedy.

Sage is easily cultivated and will grow in any well-drained fertile soil, but seems to thrive best in a rich clayey loam. For cultivation on a large scale the seeds are sown in early spring in rows from 2 to 3 feet apart, and when the plants are well up they are thinned to stand about 12 inches apart in the row. Seedling plants have a tendency to produce narrow leaves; hence, the broad-leaved varieties which do not flower readily are the most desirable, since they give a larger yield of leaves. As the plants rarely set seed, they are usually grown from cuttings, which may be obtained from seed houses having their own propagating gardens. Cuttings set as early in the spring as weather conditions will permit usually give a large crop. In the North the plants should

be protected in winter by a mulch of manure. Sage may also be grown as a second crop after early vegetables.

A fair crop of leaves may be harvested the first season and a much larger one for five or six years following. Only one picking should be made the first year, after which two or three pickings may be made in a season. If a product of fine quality is desired, the leaves are picked by hand and dried in the shade. Sage leaves are apt to turn black while drying unless the removal of moisture proceeds continually until they are fully dry. A cheap grade may be obtained at a smaller harvest cost by cutting the plants with a mower, the cutter bar of which is set at such a height as not to include the woody stems. The dry herb should be marketed promptly, since it loses its strength rapidly with age.



FIG. 8.—Seneca snakeroot (*Polygala senega*).

Returns from experimental areas indicate that on good soil a yield of 2,000 pounds or more of dried tops per acre may be expected. In case the leaves only are harvested, the yield will be proportionately less. American leaf sage usually brings a considerably higher price than that imported from Europe. During the last three years the price has ranged from 20 to 70 cents a pound, according to supply and demand.

SENECA SNAKEROOT.

Seneca snakeroot, known also as senega or seneca root (*Polygala senega*, fig. 8), is a small native perennial, occurring in rocky woods in the eastern United States and Canada. Seneca is not yet grown on a commercial scale, although cultivated experimentally in a number of places. The root is used in medicine.

Seneca can be grown in good garden soil or in rather firm, stony soil, provided it contains a fair proportion of leaf mold or very well rotted manure. Shade is not essential, although the plant thrives in partial shade or under modified forest conditions. Roots for propagation may be obtained from dealers or may be collected from the wild in autumn or early spring. If set 15 inches apart in rows, the plants may be readily cultivated until they reach a marketable size. The seeds ripen in June and may then be planted, or they may be stratified by mixing with sand and buried in boxes or flower pots in moist soil until the following spring, when they may be sown in seed beds or shallow boxes of loam and leaf mold. The seedlings when old enough to be handled safely may be transplanted to the permanent beds and set in rows to facilitate cultivation. In cold situations they will probably need to be protected during the first winter after transplanting. A light covering of straw or pine needles will be sufficient to protect them from severe frost.

The plant is slow in growth, but experiments thus far indicate that about four years are required to obtain marketable roots. The roots should be dug in the fall, thoroughly cleaned, and dried. There are no reliable data on the probable yield. Seneca root is in constant demand, and collectors formerly received from 35 to 50 cents a pound. The price to collectors in June, 1920, was 90 cents a pound.

SERPENTARIA.

Serpentaria, or Virginia snakeroot (*Aristolochia serpentaria*), is a native perennial plant occurring in rich woods in the eastern part of the United States, and most abundantly along the Allegheny Mountains. The roots of this plant are used in medicine.

Like many other woodland plants, serpentaria requires a rich, moist loam and partial shade for its best development. It may be readily propagated from seeds, which, however, require several months for germination. The seeds are best sown in a well-prepared seed bed as soon as they are ripe. They may also be sown broadcast or in drills 6 inches apart and lightly covered with leaf mold. A thin mulch of straw or leaves will afford the necessary winter protection. In the spring the plants may be set 6 inches apart each way in the permanent beds. Plantings have been made in the open, in which case the plants were set 4 inches apart in rows 16 inches apart, but the results have been less satisfactory than with plantings made under shade.

The roots are collected in the fall, thoroughly cleaned, and carefully dried. Satisfactory data on probable yields under cultivation are not available. The price usually ranges from 30 to 45 cents a pound.

SPEARMINT.

Spearmint (*Mentha spicata*) is a well-known perennial of the mint family which is very frequently found growing wild in moist situations throughout the eastern half of the United States. It is widely used for seasoning meats, and the leaves and flowering tops, as well as the volatile oil distilled from the whole herb, form marketable drug products.

Spearmint is easily grown in any fertile soil which is fairly moist. Its culture and the method of distilling the volatile oil are the same as for peppermint. To prepare the dry herb for market the leaves and flowering tops are collected when the first flowers appear and before the leaves begin to fall and are carefully dried in the shade. The demand for the dry herb is small, but the annual market requirement for the oil is about 50,000 pounds.

On ordinary soils the yield of oil varies from 10 to 20 pounds per acre, according to stand and season, but on muck lands the yield is usually only a little less than that of peppermint. Before the war the wholesale prices for the oil ranged from \$1.50 to \$5, averaging about \$3.30 a pound. The price in June, 1920, was \$12 a pound. The dry herb, which formerly brought from 3 to 4 cents, is now quoted at 6 to 12 cents a pound.

For further information on the growing of spearmint, see Farmers' Bulletin 694, entitled "The Cultivation of Peppermint and Spearmint."

STRAMONIUM.

Stramonium, Jamestown weed, or jimson weed (*Datura stramonium*), is a poisonous annual of the nightshade family, which occurs as a common weed in almost all parts of this country except the West and North. The leaves and seeds are used medicinally.

Although stramonium grows wild on a variety of soils, it thrives best under cultivation in rich and rather heavy soils which are fairly well supplied with lime. It grows readily from seed, which may be sown in the open early in the spring in drills 3 feet apart and barely covered. When the plants are well established they are thinned to stand 12 to 15 inches apart in the row. The plants can be readily transplanted, and gaps occurring in the rows may be filled in with the plants removed in thinning. Cultivation sufficient to keep the soil free from weeds is necessary for good growth.

Cultivated plants are frequently attacked by leaf-eating insects, especially in the early stages of growth, and it is often necessary to use lime or other insect repellents to prevent the destruction of the crop.

The leaves, which are collected when the plant is in full bloom, may be picked in the field, but time will be saved if the entire plant is cut and dried in an artificially heated curing room at a temperature of 100° to 110° F. When the leaves are dry they can be readily stripped from the stems, and should be baled for shipment. Such seed as is ripe may be easily thrashed out of the capsules after the leaves have been removed from the stems.

Yields of dry leaf at the rate of 1,000 to 1,500 pounds per acre have been obtained. The yield of seed is much more variable, and is estimated to range from 500 to 2,000 pounds per acre. The prewar price for the leaves varied from 2 to 10 cents and for the seed from 3 to 7 cents a pound. The price in June, 1920, for the leaves was 22 cents and for the seed 12 cents a pound.

TANSY.

Tansy (*Tanacetum vulgare*) is a European perennial plant, long cultivated in this country in gardens, from which it has escaped, and it now occurs as a weed along fence rows and roadsides. The leaves and flowering tops are in some demand for medicinal purposes. The herb also yields a volatile oil, for which there is a small market.

Tansy grows well on almost any good soil, but rich and rather heavy soils well supplied with moisture favor a heavy growth of herb. It may be propagated from seed, but is more readily propagated by division of the roots early in spring. The divisions are set 18 inches apart in rows 3 feet apart. Seed may be sown very early in the spring in the open or in seed beds, and the seedlings later transplanted to the field. Such cultivation as is usually given to garden crops will be sufficient.

The plants are cut late in the summer when in full flower, the leaves and tops being separated from the stems and dried without exposure to the sun,

as the trade desires a bright-green color. For the volatile oil the plants are allowed to lie in the field after cutting until they have lost a considerable portion of their moisture. They are then brought to the still and the oil removed by the usual method of steam distillation.

A yield of about 2,000 pounds of dry leaves and flowering tops per acre may be obtained under good conditions. The yield of oil varies, but about 20 pounds per acre is a fair average. In the United States the center of production of oil of tansy is Michigan, where about 2,500 pounds are distilled annually. The price of the oil in June, 1920, was about \$8 a pound. The price of the leaves and tops usually ranges from 3 to 5 cents a pound.

THYME.

Thyme (*Thymus vulgaris*) is a shrublike perennial plant of the mint family, native to southwestern Europe. It is a common garden plant, which lives for many years under good culture. The herb, often used for seasoning and flavoring, yields the oil of thyme, which has well-recognized medicinal properties.

Thyme grows well from seed, which may be sown early in the spring in drills 3 feet apart, or the plants may be started in a greenhouse or in seed beds outside and later set at intervals of about 18 inches in rows 2 to 3 feet apart. Thyme may also be propagated, like geraniums, from cuttings rooted in sand under glass. The plants grow well in mellow upland soil of good quality, and should be well cultivated and kept free from weeds throughout the growing season.

For preparing the dry herb only the flowering tops are used, and these are cut when the plant is in full bloom and carefully dried in the shade in order to preserve the natural color. The volatile oil is obtained from the entire herb, which is preferably cut when in full flower and subjected to steam distillation without previous drying.

Returns from experimental areas have shown great variations in the yield, which has averaged about a ton of green herb per acre. Normally the yield from a planting increases for several years, as the plants become better established, and yields at the rate of about a ton of dry herb per acre have been reported. The wholesale price in June, 1920, for the dry herb ranged from 11 to 15 cents a pound; for the imported oil, from \$1.85 to \$2.25 a pound, according to quality.

VALERIAN.

Valerian (*Valeriana officinalis*) is a hardy herbaceous perennial, well known under the name "garden heliotrope" and often grown as an ornamental plant. It has also been cultivated as a drug plant in New York and in parts of New England. The dried roots (rhizome and roots) form the marketable drug.

Valerian grows well in all ordinary soils, but thrives in a rich and rather heavy loam which is well supplied with moisture. It may be readily propagated by dividing the old roots, either in the fall or in the spring, and setting the divisions about a foot apart in rows 2 to 3 feet apart. If the divisions are set very early in the fall in time to become well established before frost, a good crop may usually be harvested the following autumn. Plants may also be grown from seed, which are preferably sown as soon as they are ripe in well-protected seed beds in the garden. Early in the spring the seedlings may be transplanted to the field and set at the same distances apart as the divisions of the root. Growth will be favored by a liberal application of farmyard manure, which should be well worked into the soil before the plants are set out. Thorough cultivation is essential.

The roots of the plants propagated by division may be dug in the fall of the first year's growth, although the yield will probably be small. Those of seedling plants do not usually reach a size suitable for harvesting before the end of the second growing season. After digging, the roots are washed, preferably in running water, until all adhering soil is removed. Washing and drying will be facilitated if the thick portion of the roots is sliced lengthwise. The drying should be very thorough, and the use of artificial heat will be found advisable.

Under good conditions a yield of 2,000 pounds or more of dried roots per acre may reasonably be expected. The prewar price ranged from 6 to 30 cents a pound, depending upon the place where grown, that from England usually commanding the highest price. The wholesale price in June, 1920, was about 22 cents a pound.

VETIVER.

Vetiver, or cuscus grass (*Vetiveria zizanioides*), is a perennial of the grass family, native to southern Asia. It is occasionally cultivated in this country in the warmer portions of the Gulf Coast States as an ornamental and also for its aromatic roots, which are often used to impart a fragrance to clothing. In other countries an oil is distilled from the roots and used in the manufacture of perfumes.

Vetiver will grow in almost any soil, but light, sandy soil enriched by farmyard manure is to be preferred. Propagation is effected by dividing old clumps, which may be set in the field, either in the fall or spring, about 4 or 5 feet apart each way. During the growing season the plants are given sufficient cultivation to keep them free from weeds. Vetiver grows in close bunches from 6 to 8 feet high, the numerous roots spreading horizontally about 2 feet on all sides of the plant.

Harvesting the roots, which usually takes place in November, is a laborious operation. The soil about the plants is opened with a stout, sharp spade in a circle large enough to include most of the roots. The earth is then dug from beneath the center of the plant and the entire clump lifted. The roots are first beaten or shaken to free them from adhering soil, then cut off close to the root crown and thoroughly washed. They may be dried in the open air, but it is preferable to dry them in a closed room at a low temperature, since they lose in fragrance if exposed to the hot sun or to a free circulation of air.

Yields at the rate of 600 to 1,000 pounds of dry roots per acre have been obtained. The prices in the markets of New Orleans are said to range from 75 cents to \$1 a pound. The oil is not produced commercially in this country. The demand for both roots and oil is quite small, and it has not yet been shown that vetiver would be a profitable crop in the United States.

WINTERGREEN.

Wintergreen (*Gaultheria procumbens*) is a low-growing, broad-leaved, evergreen plant with a creeping stem. The shoots from this stem grow to a height of 4 to 5 inches and bear solitary white flowers, which are followed by red berries. These berries are edible and are widely known as teaberries or checkerberries. Wintergreen is a common plant in woods and clearings from eastern Canada southward to the Gulf States, but its collection in quantity is somewhat difficult. Both the dry herb and the oil form marketable products.

Like other woodland plants, wintergreen thrives only in partial shade, and plantings should be made in a grove or under a specially constructed shade, such as is used for ginseng or goldenseal. A fairly good growth may be expected in soil which is thoroughly mixed with leaf mold to a depth of 4 inches or more. Wild plants may be used for propagation. Divisions of these may be set in the fall or spring, about 6 inches apart each way, in permanent beds.

Wintergreen is usually gathered in October or at the end of the growing season. The plants are carefully dried and packed in bags or boxes for marketing. For the production of the volatile oil the plants are soaked in water for about 24 hours and then distilled with steam. Over 22,000 pounds of wintergreen oil were produced in this country in 1909 and 6,000 pounds in 1914.

The prewar price of the oil distilled from the wintergreen plant as quoted in the wholesale drug markets generally ranged from \$3 to \$5 a pound. Recently the lack of labor has reduced the output of oil, and in consequence the price has advanced. The oil became practically unobtainable on the markets in October, 1919, at which time it had reached a price of \$11 a pound. Collectors usually receive from 4 to 5 cents a pound for the dry herb. The results of numerous trials indicate that, on account of the small yield, wintergreen production under cultivation is not likely to be profitable at the prices quoted.

WORMSEED, AMERICAN.

American wormseed, or Jerusalem oak (*Chenopodium ambrosioides anthelminticum*), is a coarse weed, occurring commonly in waste places and often in cultivated ground throughout the eastern and southern parts of the United States. The seeds (fruits) and the volatile oil distilled from the tops of the plant are employed in medicine.

This plant grows well under cultivation in almost any soil, but a good sandy loam is preferred. It is now cultivated for oil production only in a small area in Carroll County, Md. The seed is sown in well-prepared beds about March 1, and between May 15 and June 15, when the seedlings are 4 to 5 inches tall, they are transplanted and set about 10 inches apart in rows about 3 feet apart. The soil is kept entirely free from weeds by shallow cultivation throughout the growing season.

Harvesting is usually begun early in September or as soon as the seeds have taken on a black color, but before the plants have turned brown. If harvesting is delayed until the plants are fully mature there will be considerable loss through shattering and a diminution in the yield of oil when they are distilled. The crop is harvested with large knives or sickles, either by cutting off the entire plant at the ground or by cutting the branches separately. The latter method saves the labor of handling a quantity of useless woody material and also requires a smaller still capacity to handle the crop. After cutting, the plants are laid out on the ground in rows and allowed to cure for about three days before they are distilled.

In the South wormseed has been grown successfully as a seed crop. The ground is prepared in February and laid off in rows about 4 feet apart. A furrow is opened in each row, in which a complete fertilizer is applied at the rate of 400 to 500 pounds per acre. The soil on each side of the row is thrown in with a turnplow, forming a low ridge, which is then flattened with a light roller. The seeds are sown on this ridge with a drill. The plants are thinned to stand 18 inches apart in the row and are given frequent shallow cultivation.

The crop should be ready for harvesting late in July or early in August and should be cut before the tops begin to take on a brown color. The plants are cut either with a mower or old-style grain reaper and are left in the field until thoroughly dry. They may be housed and the seed thrashed out when convenient, but, since the seeds shatter easily, waste will be avoided if the plants are thrown upon large canvas sheets and the seed thrashed out in the field. The seed is light and not easily cleaned, but wire sieves of suitable mesh have proved very satisfactory for this purpose.

The yield of seed per acre averages about 1,000 pounds. The yield of oil varies, but under favorable conditions about 40 pounds per acre is regarded as a fair average. The area planted varies according to the price of the oil and may range from 175 to 450 acres. The average annual production of oil is estimated by producers to be 10,000 to 12,000 pounds.

The prewar price of wormseed ranged from 6 to 8 cents a pound. The price in June, 1920, was about 15 cents a pound. The prewar price of the oil ranged from \$1.40 to \$5.50 a pound. The price in June, 1920, was \$9 to \$9.50 a pound.

WORMWOOD.

Wormwood (*Artemisia absinthium*) is a hardy herbaceous Old World perennial of the aster family, which has escaped from cultivation in this country and now occurs as a weed in many localities in the southern part of the United States. For many years it has been grown commercially on a small scale, chiefly in Michigan and Wisconsin. The dried leaves and tops have long been used medicinally, but the volatile oil distilled from the plant now forms the principal marketable product.

Wormwood will grow in almost any soil, but the best results are to be expected in deep, rich, moderately moist loams. The seeds are frequently sown broadcast early in the fall, following a grain crop; but if the plants are to be cultivated, it is best to start them from seeds sown in seed beds early in the spring or from cuttings of the young shoots taken in the spring and rooted in sand under glass or in the shade of a lath shed. The seeds are very small and should be sown on the surface of the soil in coldframes or seed beds and lightly covered with very fine sandy soil. The plants are easily handled and may be transplanted in moist weather with good results at almost any time during the growing season. They are set about 18 inches apart in rows 3 or 4 feet apart and are well cultivated. The soil should be kept absolutely free from weeds, since their presence in the crop at harvest time seriously damages the quality of the oil. A fair cutting of the herb may be expected the first year after planting and full crops for two or three successive seasons, after which new plantings will be found more satisfactory.

The plants are harvested when in full bloom and may be cut with a scythe, or a reaper may be used if the area is large. While still fresh, the plants are distilled with steam to obtain the volatile oil. To prepare the leaves and flowering tops for market they are stripped from the stems by hand after the plants are cut and carefully dried in the shade without the use of artificial heat.

Experimental plantings have given yields at the rate of 2,000 pounds of dry tops or 40 pounds of oil per acre. When grown on a commercial scale the yield of oil appears to average about 20 pounds per acre.

The prewar price of the dry tops was about 6 or 7 cents a pound. Its price in June, 1920, was 17 to 18 cents a pound. The oil was once used extensively in the manufacture of absinth, but when the use of this product was restricted in 1912 the demand for the oil fell off and the price declined, until in the early part of 1915 it reached the low level of \$2 a pound. The price in June, 1920, was about \$13 a pound. The average annual production of oil of wormwood is about 2,000 pounds. Owing to the limited use of this oil, there appears to be little room for further profitable expansion of this industry.

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